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AMERICAN WATER WORKS ASSOCIATION

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CONTENTS

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AMERICAN WATER WORKS ASSOCIATION

Vol. 29 August, 1937 No. 8

LICENSING OF WATER WORKS EMPLOYEES*

By Lewis V. Carpenter

(*Professor of Sanitary Engineering, New York University*)

The Board of Directors of the American Water Works Association at their January Meeting passed the following resolution:

"The Board of Directors of the American Water Works Association realizing the importance of efficient operation of water purification plants as a protection to public health, endorses licensing, certification, or some form of regulation of water purification plant operators and supervisors as a means of preventing the employment of incompetent personnel and assuring some continuity of employment of efficient personnel. Sections of the A. W. W. A. are hereby encouraged to engage in voluntary licensing."

The last sentence was placed in the resolution because voluntary licensing has been highly successful in some states. Cohen (1), of Texas, feels that the voluntary licensing has worked out so well that a state law requiring it would not strengthen their situation. The first license granted under the Texas system is Grade C, which every one must obtain before getting a higher grade license. The

* The report of a Committee, of which the author is Chairman, presented at the Buffalo convention, June 8, 1937. The report was accepted by the Board of Directors, A. W. W. A. and is herewith published for the information of all persons interested.

Class C license is only valid for three years from the date of issue. This means, of course, that the operator must continue to study and prepare himself to take the next examination in order to hold his grade at the end of the expiration period. To date, something over 400 licenses have been issued (1). "The fact in which we take chief pride is that not one complaint has been made by any person, regarding any feature of the program, and that the entire waterworks profession in Texas is unanimously behind this effort to improve working conditions."

The California Section of the A. W. W. A. licenses members of the association only.

Paul Weir, Atlanta, (2) writes: "Approximately two-thirds of all eligible operators are members of the Georgia Water Works and Sewerage Operators' Association. Class A, B and C certificates are now being issued at each short school. This work is still conducted along voluntary lines, in that it has not been deemed advisable, for the time being at least, to attempt to secure legal licensing through the legislature."

South Carolina has a plan for certification of water plant operators that is unique. B. P. Rice (3) writes: "We have had several practical schools for water plant operators, and beginning with the school which will be held in Columbia on June 15 and 16, the operators are going to be examined on what they do at each school. All passing with a satisfactory mark of seventy or more will be issued certificates by the South Carolina Water Works Association. The said certificates will be approved by the State Health Officer.

"We plan that when seventy-five percent of the operators have passed the above mentioned examinations, and have certificates, to have the Executive Committee of the State Board of Health to pass a rule and regulation, which will have the force and effect of law, that no plant can be operated as a public water supply, unless it is in charge of an operator possessing a certificate issued by the Water Works Association and approved by the State Board of Health."

New York State joins the ranks of the states which have legal licensing. The Public Health Council is given power subject to approval by the Commissioner of Health, to prescribe regulations for the qualifications of dairy and milk inspectors, operators of public sewage treatment plants and operators of public water treatment and purification plants, if the appointees are paid from

public funds. The bill applies to appointments made after June 30, 1937, but appointments may be made from Civil Service lists if established prior to July 1, 1937. The bill becomes effective on July 1 and the Sanitary Engineering Division of the State Department of Health are setting up regulations for enforcing the bill. Unfortunately, this bill does not regulate the private water companies.

Wisconsin introduced a licensing bill which on May 17 had been up for hearing, but had not been reported out of committee for passage. Some opposition was encountered on the grounds that the measure would interfere with the prerogative of municipal officials in hiring and firing employees.

At the present time, licensing exists in some form in nine states: California, Georgia, Michigan, New Jersey, New York, Ohio, South Carolina, Texas, and West Virginia.

The A. W. W. A. has combined the committee on licensing with the committee on short schools. Jordan (4) states: "The combination of licensing and water works schools, on the one hand, trains men for the improvement in water supply service for which every city and state should strive, and on the other hand assures the water works personnel the degree of security and community respect to which any hard-working, willing employee is entitled."

Hopkins (5) comments on the above paragraph as follows: "In disagreement with this belief, it is apparent that the assistance given to the individual by short school training is definite and tangible, but the value to be derived from a licensing system is not at all clear.

"Regulation would not improve the 'professional' standing of the technical operator or raise to any degree the standards. The remedy lies in educating appointing authorities to a realization of the fundamental sciences involved, with a resultant appreciation of well trained personnel. The legal advisor to the smallest town is a trained lawyer, the health officer usually a trained medical doctor; why should economic objections be raised to professional personnel in charge of purification plants as an adequate safeguard to public health?"

The principal answer to Mr. Hopkins' comments would be another question. Why do they require trained lawyers and physicians in even the smallest town? The answer is apparent. No doctor or lawyer can practice their profession unless they have state author-

ity, granted by examination. Practice in the past has been to place any good politician in the water department and change with every change in political administration. Education of public officials has not been so successful when they need public jobs for political patronage. As noted before, the principal objection raised to a licensing bill in Wisconsin was not its merits, but that it would interfere with the prerogatives of municipal officials in hiring and firing employees.

Every state which has tried licensing has been heartily in favor of it. Education of the public is very important and it is also very important to protect the operating personnel and public health while the public is being educated.

The analogy of the doctor and lawyer is not applicable to small towns. A lawyer can serve as a legal adviser for towns as large as 20,000 people and still devote but a small part of his time to the municipality and the most of his income will be derived from his private practice. Essentially the same is true of the doctor; but the water plant operator must be a full time employee, deriving his entire income from his plant position. Naturally, it is not possible to get a well educated plant operator in a town of a few thousand people at the salary they can afford to pay. Some form of licensing with the short school to keep plant personnel aware of new developments seems to be the ideal solution at the present time. I think every one agrees that a man with a college education involving chemistry of colloids, physical chemistry, etc., with several years practical operating experience would produce the ideal operator; but we will have to wait until that type of personnel can be educated and trained and some brilliant economist can devise ways and means of paying him in a small town.

The interest in licensing has been increasing rapidly. Practically all sections of the country have committees of water works men studying the problems arising therefrom (6). Certainly some form of voluntary licensing could be established while formulating laws so that the existing personnel who would get in under the grandfather clause, can be educated before laws are passed.

HOW TO SECURE LICENSING REGULATIONS

The Public Health Laws in practically every State give the State Department of Health the power to set up rules and regulations to insure the delivery to the public of a safe potable water supply.

The Health Department also has the power to cause the removal of unsuitable personnel and replace them with qualified men, if it can show cause why an unqualified man is apt to endanger public health. Should the State Department of Health be so inclined, it can set up licensing of water purification plant operators in most states without additional legislation. One procedure for having licensing procedure adopted in any state would be as follows:

(1) Sell the water works employees on the advantages of licensing.

(2) Pursue a vigorous publicity campaign on the issue before the public, stressing the protection that it will be to public health.

(3) Sell the idea to the State Department of Health.

(4) Examine the State Public Health Laws, and look for some clause which permits the State Department of Health to issue regulations governing water works operators.

(5) If such a clause exists, get the opinion of the Attorney General on the legality of setting up licensing regulations under this clause.

(6) If it is possible to get these regulations without special legislation, licensing can be started very soon.

The writer talked to a member of the State Department of Health of a certain state which has a committee preparing a special bill. He was asked if in his opinion, such a law was needed, and he said it was not. The Health Department had the power to set up any regulations which it felt necessary, but the department officials would prefer a specific law so that it would be mandatory on them. A number of states could have licensing under existing laws, if the plant operators would insist that licensing be started.

TYPES OF LEGISLATION AND REGULATIONS

If the state law does not permit licensing under existing laws, it is necessary to prepare a bill. The law should delegate to the Sanitary Engineering Division of the Health Department, the authority to set up regulations governing licensing. It is preferable that a legislative bill be brief and not contain classification of operators. A number of features which should be included in the law and regulations pertaining thereto should be:

1. Provide for annual or bi-annual renewal of licensing certificates at a very nominal fee. Frequently, a plant operator will obtain a license and then go into some other type of work. A number of years later, he might want to operate a plant again. This operator should have to then take an examination to see if he has

kept up with the newer developments. Recently, in the State of New Jersey, an operator was removed from his job for political reasons. The Health Department, of course, could insist that he be replaced by a licensed operator. A man, who held a certificate issued over ten years ago, was appointed. During this period he had worked in an unrelated field.

The renewal of licenses should be made without examination, except that the Department of Health should have the power to require examinations if they feel that the conditions warrant it. The cost of renewal of certificates should not exceed $1.00.

2. Provide for classification of operators. This requirement should not be placed in the bill, but the power to classify operators should be delegated to the Department of Health. The States of Michigan and West Virginia found that, after once introducing licensing, they were able to improve the class of personnel by gradually increasing the qualifications, and educating and training the men to meet the higher requirements. The entrance qualifications should be low, because the success of short schools in this country has demonstrated that if some degree of security can be offered to the operators, they are eager to improve their knowledge.

3. Provide for tenure of office. A plant operator who has worked three or more years at a particular plant should not be removed without filing particular charges against him as long as he retains his certificate. This clause would prevent political turnover of personnel.

4. Provide for adequacy of compensation. In a municipally operated water plant, the municipal governing board should not be permitted to reduce salaries of water plant operators, except by state law or approval of the Health Department. This stipulation would prevent the reduction of pay of an employee in order to force him to resign.

5. Provide for present plant operators. A "grandfather clause" to allow operators who have been working in a plant three or more years to be licensed without examination. An operator licensed under the "grandfather clause" should have a certificate limited to the plant he is operating when the regulations go into effect.

A law containing all of these features would be highly desirable. The state law in some states would prohibit some of the restrictions and individual states would have to prepare a bill suitable to their requirements. It is not necessary to get everything that is desir-

able in the first bill. Bills can be revised after they are once on the statute books. The American Water Works Association has a committee which furnishes aid to states that are interested in improving the working conditions of their water works personnel by introducing licensing or certification of water purification plant operators. It is up to the water works men in various states to get behind their own problem. If they want licensing and will exert the necessary effort, they can get it.

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THE LICENSING OF WATER WORKS OPERATORS MICHIGAN EXPERIENCE*

By Edward D. Rich

(*Director, Bureau of Engineering*)

(*Michigan Dept. of Health, Lansing, Michigan*)

In 1915 the Michigan Department of Health passed a regulation effective January 1, 1916, requiring that all municipalities and water companies treating water, either by filtration or chlorination, to be sold the public, must provide a laboratory with a qualified person in charge who would make the tests necessary at each particular plant and report the results together with essential operating data to the Michigan Department of Health each month on blanks furnished by the state for that purpose. The state also specifies what tests are necessary at each plant. We regard this as the most important policy ever adopted by the department for the efficient management of water treatment plants.

In the years 1923, 1924, 1925, the operators were invited by the department to meet in Lansing in connection with the annual meeting of the State Health Officers' Association for discussion of their problems and to receive advice from the engineering bureau of the department. These meetings were enthusiastically attended, and in 1926 the operators formed an organization known as the Michigan Conference on Water Purification. Since that time the officers of the conference have managed the meetings.

A committee prepares the program which consists largely of papers and discussions by the members. Usually it is possible to have at least one outside speaker of renown to address the meeting. At the 1930 session of the conference the problem of certification of water plant operators was discussed and a committee was appointed to confer with the Commissioner of Health regarding the passing of regulations requiring certification. The idea in the minds of the members was, I think, primarily to stabilize their jobs, but they

* Presented at the Buffalo Convention, June 8, 1937.

undoubtedly had a keen sense of the probability that certification would tend very strongly to encourage the men to improve themselves so that they might secure higher ratings. A great deal of improvement in the quality of service which has been rendered to the various plants in Michigan has been manifest. It is difficult to say how much of this is due to certification and how much is due to the papers and discussions which have taken place at the annual meetings of the conference. The results have been exceedingly gratifying to the department.

As a result of the agitation on the part of the operators, the department passed regulations on August 13, 1931. These regulations provide as follows:

(1) Each treatment plant is to be under the "supervision of a trained attendant whose ability to perform the duties required have been certified to by the Michigan Department of Health."

(2) That the Michigan Department of Health shall set up rules for examination and certification.

(3) That no person in responsible charge of a plant may be employed who has not been certified.

(4) That the Michigan Department of Health may, when deemed necessary, require the supervision of any water disinfection plant by a certified analyst.

Under these regulations certain rules were adopted as follows:

(1) No fee is charged for examination or certification.

(2) A written application is required.

(3) Examinations are under the direction of the Bureau of Engineering. They are in two parts,—a written portion and a laboratory demonstration. They are to test fairly the ability of the candidate to discharge the duties of the position to which he aspires. Those who pass the examination form a list from which recommendations for appointments are made.

(4) The department designates the class of supervision which is necessary at each plant.

(5) The State Commissioner of Health may appoint a Board of Examiners consisting of three persons, one a member of the Engineering Bureau of the department and at least one to be in responsible charge of a plant. At the present time this board consists of the assistant engineer in charge of water filter plants, the operator of a large filter plant and a consulting engineer in active practice who was formerly an assistant in the engineering bureau.

(6) Provides for the promotion of operators second class by examination.

(7) Filter attendants, that is, those who do certain routine manual tasks about the plant such as washing filters and collecting samples are not required to be certified.

(8) It is a violation of the rules of the department to employ as the person in responsible charge of a plant one who is not certified and it is provided that those persons in charge of the various plants at the time the rules took effect should be continued in office. These operators were required by the Board of Examiners to submit a record of their experience and training. After a careful examination of these statements and a thorough discussion of them by the board, recommendations were made to the Commissioner of Health to issue certificates to these men at a grade appropriate to their qualifications without examination. The Commissioner complied with the recommendations and certificates were issued.

STATE OF MICHIGAN

Department of Health

This is to certify that ____________________

has fulfilled the requirements of a Regulation adopted by the Commissioner of Health with the concurrence of the Advisory Council of Health relative to the Certification of Water Treatment Plant Operators, and is hereby granted this Certificate as an

OPERATOR 1st CLASS

This Certificate is to be in full force and effect unless revoked for cause.

IN WITNESS WHEREOF The Commissioner of Health has subscribed his name and caused the Seal of the Michigan Department of Health to be attached hereto in Lansing this______day of_______193_

____________________M. D., Dr. P. H.

No.________ COMMISSIONER OF HEALTH

The qualifications for examination for an operator first class are that his experience must be such as to justify his being in charge of a plant having all the processes of water treatment including softening. He shall also be well-informed concerning the necessary

mechanical equipment of a plant. He must be familiar with the laws of the state of Michigan relative to water resources and purification. He shall have had an education equivalent to that required by recognized universities for the bachelor degree and in addition at least two years' experience as an operator second class, or in lieu thereof at least six years of varied experience as an operator.

The qualifications for operator second class include knowledge of all the methods of water treatment except softening. The applicant must have sufficient training to be able to handle efficiently the standard type of filter plant where softening is not required, and shall have at least the equivalent of a high school education.

The candidate for analyst must have such experience and training as may be deemed necessary for supervision of a water disinfection plant.

The designations "operator first class" and "operator second class" are slightly misleading. The class refers not to the man but to the plant. It would be more proper to say "operator of a first class plant" and "operator of a second class plant."

The examining board formulates the questions and conducts the examination and each member of the board marks the examination papers independently. These are turned in by number and the number and corresponding name are submitted in a sealed envelope to be opened after all the members of the board have examined the papers. The examining board also recommends to the Commissioner the classifications of the various plants.

At the present time there are eight plants in Michigan using the softening process and 30 others of the standard filtration type. Operators of five of the second class plants hold certificates as operators first class. These are required in certain plants of large size or plants having an exceedingly difficult water to treat or some other critical problem to meet. There are a few laboratory employees in the larger plants who hold certificates as analysts. We encourage this because we believe it tends to develop ambition in the subordinate to attain a higher rating and ultimately to be a candidate to take charge of an independent plant. In plants where chlorination is the only treatment an analyst's certificate is required.

In some plants there will be two persons employed who are qualified to hold the same grade of certificate. When this occurs, we issue the certificate to the man in responsible charge of the plant

and to the other a letter of competency stating that he is qualified to hold a certificate of that particular class and when circumstances arise under which he would be required to have the certificate, it will be issued to him. This occurs when a subordinate leaves a plant to take charge of an independent plant, or when the superior leaves office for any cause.

We find this is an important feature in handling the matter so as to avoid controversies and misunderstandings.

Some time ago certificates for operator second class were issued to two men in a small plant because at the time they were issued the man normally in charge was absent on sick leave. When he returned there were two men employed at the plant having the same grade of certificate. One of the members of the city council raised the question as to why they needed to pay two men having equal qualifications and proposed that the highest paid one of the two be discharged. This was not done when adequate explanations were made. This is the reason why the policy of issuing letters of competency was adopted.

When a new plant is opened, particularly a small one, we are often confronted with the request that some local person who has become interested during the construction of the plant be designated as operator. When this happens the local officials are informed that the rules and regulations require a certified operator. If they wish, they are permitted to employ a certified operator from another plant provided he is at liberty to spend time enough to thoroughly supervise the operation of the new plant and direct and instruct the person who is ambitious to become the operator. This has been done in several instances and has given satisfactory results. The supervision by the outside certified operator is required to be continued until the candidate for operator can qualify by passing the examination and receiving the approval of the department.

The examinations have been held annually so far and there does not seem to be any indication that they will be needed more frequently. At the last examination held this spring candidates appeared for examination as follows: Operator first class, 4; operator second class, 15; analyst, 7; making a total of 26. The books have not yet been marked by all the members of the board but it is evident that a fairly good proportion of the candidates passed the examination. At present there are in effect certificates as follows: Operator first class, 17; operator second class, 32; analyst, 39; total

88. Of these, five operators second class and two analysts have letters of competency for a higher grade.

The same general method has been used in handling operators of sewage treatment plants. The sewage treatment plant operators' meetings began in 1924 and their organization was perfected in 1927. The operation of the rules and regulations is entirely separate from those of the water plant operators and is handled by a distinct board.

We feel that the certification of operators has been beneficial in several respects: (1) It improves the respect for the water department by the municipal officials. (2) It encourages the men to improve themselves. (3) It stabilizes employment and reduces changes of personnel. (4) It increases interest in the plant on the part of the public. (5) It attracts higher grade men to these positions and thereby insures better salaries being paid.

A copy of the original 1916 resolution, the resolution of 1931, the rules and regulations, the requirements for examination and copies of the certificates are hereto attached.

Resolution of Michigan State Board of Health Relative to Operation of Plants Furnishing Water Supply

Resolved, That after January 1, 1916, all corporations, both municipal and private, partnerships and individuals, engaged in furnishing water to the public for household or drinking purposes, which are now operating, or may hereafter operate, any filtration or sterilization plant or any other means of purifying water before it is delivered to the consumer shall be required to submit monthly reports of the details of operation and the tests of efficiency of such plants on the blanks, prepared by the State Board of Health, for these purposes.

Resolved further, That any corporation, partnership or individual not having facilities for making the tests required by the State Board of Health which may be outlined on the blanks from time to time, shall be required to provide the necessary facilities for this purpose or to engage some competent person having suitable equipment to make the prescribed tests.

Resolved further, That it shall be the duty of the person or officer having in charge the operation of the water department or company, as the case may be, to fill out the monthly blank, and certify to the truth of the statements contained herein, and forward the same to the secretary of State Board of Health within ten days after the close of each calendar month.

Resolved further, That the secretary be authorized and instructed to send a copy of these resolutions to each municipality or company operating water treatment plants within the State at the present time, as a notification of the action of this Board.

Regulation of the Michigan Department of Health* Relative to Personnel Responsible for the Operation of Water Treatment and Disinfection Plants

1. That all corporations, both municipal and private, partnerships and individuals, engaged in furnishing water to the public for household or drinking purposes, which are now operating, or may hereafter operate, any water purification or treatment plant, shall be required to place such water purification or treatment plant under the supervision of a trained attendant whose ability to perform the duties required has been certified to by the Michigan Department of Health.

2. That the Michigan Department of Health shall set up rules pertaining to the examination and certification of water purification or treatment operators.

3. That after this date no corporation, municipal or private, partnership or individual shall employ as Superintendent of Water Purification or Treatment, Chief Chemist or Chief Operator, any person who has not been certified by the Michigan Department of Health as competent to hold such responsibility.

4. That the Michigan Department of Health may, when deemed necessary, require the supervision of any water disinfection plant by a certified analyst.

5. That a copy of these regulations shall be sent to the Mayor of each city, the President of each village and of all private corporations, partnerships and individuals now operating water treatment or disinfection plants, as a notification of the action of this department.

* * * *

Rules Governing the Certification of Water Treatment and Disinfection Plant Personnel

1. No fee shall be charged for the application, examination and certification of plant personnel.

2. Application for examination to serve as superintendent or operator shall be made in writing on blanks provided by the Michigan Department of Health within a reasonable time previous to the date on which the examination will be given. The applicant shall state on the application blank the following:

(a) The date
(b) Certificate desired
(c) Full name, residence and post office address
(d) Age, date and place of birth
(e) Business and employment for the previous six years
(f) Education
(g) Experience in work of a character similar to that for which the examination is to be given.

3. Examinations shall be given under the direction of the Michigan Department of Health, Bureau of Engineering, at such time and place as may be

*Dated at Houghton, Michigan, this 13th day of August, 1931.

designated. The examination shall be of such a character that will fairly test the ability of the person examined, to discharge the duties of the position for which a certificate is requested. The examination shall be divided in two parts, one written and the other a practical demonstration in the laboratory.

The Department may refuse to examine a candidate or issue a certificate after examination to any person who has attempted to practice any deception or fraud in his application or in his examination.

The names of all persons successfully passing the necessary examinations shall be listed in the files of the Department as eligible for appointment, and recommendations for appointment to positions shall be made from the eligible list. The names of persons holding certificates shall be published once each year in one of the publications issued by the Department.

4. The Department shall designate the class of supervision necessary in all existing and future purification or treatment plants. When additions are made to a purification or treatment plant that will result in changing the process of purification, the Department will specify the type of supervision required to meet the changed conditions.

5. The Commissioner of Health shall appoint a Board of Examiners which shall consist of three members, one of whom shall be a member of the Bureau of Engineering of the Michigan Department of Health and at least one, a superintendent of a water purification or treatment plant.

6. An Operator Second Class may apply for and receive a superintendent's certificate provided he has the necessary qualifications and successfully passes the required examination.

7. Filter attendants are not required to pass an examination nor hold a certificate.

8. No municipality, corporation or individual shall appoint any person as superintendent or operator in charge of any water purification or treatment plant purifying or treating water used for potable purposes by inhabitants of this State, or permit any persons to discharge duties of superintendent or operator in charge of such plant who is not the holder of a certificate issued by the Michigan Department of Health, provided, however, that nothing herein contained shall prevent any municipality, corporation or individual from continuing in office any qualified person now employed as superintendent or operator in charge of any water purification or treatment plant.

9. These rules shall take immediate effect.

Certificates for Operators and Analysts

A. Operator First Class, or Superintendent's Certificate shall be issued only to those persons having the qualifications and experience deemed necessary for capable supervision over all the operations common to water purification practice, including water softening, coagulation, sedimentation, filtration and disinfection.

The applicant shall have had (1st) sufficient training in sanitary Chemistry and Bacteriology to enable him to perform, interpret and capably supervise those laboratory procedures necessary for controlling all the technical processes employed in the art; (2nd) shall be well informed as regards the nec-

essary mechanical equipment and appurtenances in general use; (3rd) be familiar with the laws of the State of Michigan relating to the sanitary control of water resources and water purification; and (4th) shall have an education equivalent to that required by recognized universities for a bachelor degree and in addition at least two years experience as an Operator Second Class; or, in lieu thereof shall have had at least six years of such varied experience as an Operator Second Class as may be deemed necessary to assure his ability to satisfactorily meet every other requirement of this classification.

B. An Operator Second Class certificate shall be issued only to those persons having the qualifications and experience deemed necessary for the satisfactory operation and control of disinfection and one or more of the following water purification processes, viz.; simple coagulation, sedimentation, filtration and softening. The applicant shall have had (1st) training sufficient to perform and interpret the standard chemical and bacteriological laboratory tests necessary for the proper control of the various processes utilized in the type of water purification or treatment works he is expected to operate; (2nd) shall be familiar with the mechanical equipment generally found in such plants; and (3rd) he shall have at least the equivalent of a high school education.

C. An Analyst's Certificate shall be issued only to those persons who have the qualifications and training deemed necessary for satisfactory supervision over the operation of water disinfection plants.

THE LICENSING OF WATER WORKS OPERATORS CALIFORNIA EXPERIENCES*

By R. F. Goudey

(Sanitary Engineer)

(Bureau of Water Works and Supply, Los Angeles, Cal.)

On January 1, 1937 the California Section of the American Water Works Association issued 110 certificates to water treatment plant operators as authorized by a resolution of the California Section, American Water Works Association, adopted October 24, 1935.

HISTORICAL DEVELOPMENT

Licensing of operators in California was first suggested by representatives of manufacturers of water purification equipment in 1931. This year, and for each succeeding year, committees on certification of water treatment plant operators have been carrying on intensive studies and activities. In 1934 definite recommendations were formulated to carry the plan into effect which were primarily based upon the Licensing of Water Works Employees Report at the Pittsburg Convention (1931). The Committee on certification of water treatment plant operators in California covers both certification of operators and short schools for operators.

California adopted the idea of voluntary certification after careful consideration had been given to compulsory licensing. California has a State Board of Professional Standards where different groups are registered on a self-supporting basis. The number of water treatment plant operators, however, was so small that the cost to defray all of the expense involved in licensing would necessitate the fee being approximately $25. Furthermore, the state was not then in the mood of passing legislation making compulsory the licensing of water treatment plant operators. Following the suggestion given by the national committee on licensing, voluntary licensing was adopted in order to give momentum to a movement which might later make the voluntary certification compulsory.

* Presented at the Buffalo Convention June 8, 1937.

CERTIFICATION PROCEDURE

On April 20, 1936, the licensing committee sent out the following letter of transmittal covering the classifications of water works operators, practical qualifications, and the rules under which certification would be made, together with application on which to apply for certification.

Dear Sir:

For some years, the California Section of the American Water Works Association has been conducting an intensive study on the practicability of certifying water treatment plant operators according to their education, training, and experience qualifications. Similar studies have been made by a national committee of the American Water Works Association, the California Sewage Works Association, the American Chemical Society, and the American Public Health Association.

California does not have compulsory laws for the registration of water treatment plant operators and on October 25, 1935, the California Section of the American Water Works Association authorized a voluntary plan of certification. The need for certifying operators is evident from the fact that five states have compulsory registration and a number of others have voluntary certification.

The procedure for voluntary certification in California has been set up as follows:

1. There are three classifications of operators as follows:

CLASSIFICATION OF WATER WORKS OPERATORS

First Class:

All chief operators of a wide variety of types of treatment plants where chemical and laboratory control are involved.

Second Class:

All operators operating plants such as rapid sand filtration, slow sand filtration, water softening, iron removal, coagulation, chlorination other than manually operated chlorinators, ammoniation, algae treatment, or taste and odor control.

Third Class:

All operators included in the Second Class but where the operators hold subordinate positions or are more or less on an apprentice basis. In addition, operators of simple aeration and manually controlled chlorination equipment.

2. Each applicant will be classified according to his education and professional standing as follows:

QUALIFICATION FOR WATER WORKS OPERATORS

Training	*First Class*	*Experience*
Graduation of a recognized college with degree in	Sanitary Engineering	One Year
	Public Health	One Year
	Chemical Engineering	One Year
	Civil Engineering	Two Years
	B.S. Chemistry Major	Two Years
	Bachelor of Arts with courses in Water Chemistry	Three Years
	or	
Two Years College		Five Years
Graduation of High School or less than High School Education		Five to Ten Years

Training	*Second Class*	*Experience*
Graduate of a High School or its equivalent with additional training in water chemistry and bacteriology, or Pass a comprehensive examination		Two Years

Training	*Third Class*	*Experience*
Pass a comprehensive examination		Two Years

3. Any operator may apply for certification before June 1, 1936, and be classified without an oral or written examination, provided, however, that if the Committee on Certification feels that any applicant is not entitled to be fully certified, it may issue a probationary certificate which will be effective until October, 1937, after which time an oral or written examination will be required to obtain a full certificate.
4. After June 1, 1936, oral and written examinations will be given during the Annual Convention period of the California Section of the American Water Works Association.
5. An application fee of $1.00 shall be required for the original application and for every subsequent application for higher classifications.
6. Certificates shall be renewed every five years without an additional fee on receipt of information that the operator is still engaged in operating works equivalent to those for which he was formerly certified. The renewal will be a small tag validating the original certificate for the ensuing five year period.

It is hoped that all operators of water treatment plants will avail themselves of this opportunity and that City officials together with other water works managers into whose hands these documents might fall, will cooperate by for-

warding them to their qualified employees with the request that they secure certification.

The Certification Committee is carrying on this work voluntarily and it hopes to secure wholehearted cooperation from every one connected with protecting the health of persons furnished with water from treatment plants.

Yours very truly,
R. F. Goudey, *Chairman*,
Committee on Certification of Water Works Employees, California Section, American Water Works Assn.

* * * *

The committee on receiving the applications had to subdivide the three classes as regards responsibility. The Class I operator was conceived as one having two or more processes of treatment with laboratory control in which the operator was either superintendent or chief operator. Class II included superintendents and chiefs where only one type of treatment was used and which otherwise would have been a Class III classification. No experience was deemed necessary for any Class III operator. With these modifications the operators were graded and all but one operator was satisfied with the rating received. The one operator who was dissatisfied was employed where the only treatment was chlorination. This operator could undoubtedly qualify for first class rating in the event that he had two or more processes of treatment with laboratory control. In the future it is anticipated that examinations can be held so that a person can be raised from third class to second class regardless of number of treatment processes employed.

On October 28, 1937 a written and oral examination will be held for any operators seeking certification as well as operators seeking to improve their present rating. Already there have been ten persons who have signified their intention to apply for certification at the coming examination.

SUCCESS OF CERTIFICATION

At the present time the 110 certificates are divided as follows:

Class I	22
Class II	61
Class III	27

All of the large cities are represented by operators holding certificates. There were 25 cities having municipal supplies where opera-

tors received certificates and 17 additional cities and communities supplied by three of the largest private water companies in the State. Two large municipal water districts supplying eight cities also supported the plan making a total of 50 cities and communities covered with operators having certificates and including over 95 percent of the population of the State. Reports have been received to the effect that certification has assisted local water superintendents in establishing local ratings for the operators classified by the committee. Furthermore, there has been a stimulus given by certification to encourage operators to attend water works schools and improve their educational qualifications. The main weakness of voluntary certification over licensing is the fact that cities are not compelled to use operators having certificates. All effort, therefore, should be made to publicize the certification activities in order that a ground work may be laid for a vigorous program to make certification compulsory.

SCHOOLS FOR OPERATORS

The California Committee has so far established two lines of educational activities. Working jointly with the University of Southern California the committee on certification of the California Section, American Water Works Association, has established in their School of Government Division a degree called "Certificate in Water Treatment Plant Administration" where a person in late afternoon and evening courses can take certain required and elective subjects. This degree given is between that of a high school graduate and a university graduate.

An operator taking advantage of this course can improve his educational standing to the point where, with a number of years experience to his credit in operating a water treatment plant, he can make up his deficiency in a college degree in Sanitary Engineering.

A second activity for an operators' school is to be put into effect June 16–19 (1937) at the University of Southern California. This course is being given at the University of Southern California under the joint auspices of the certification and short schools committee of the California Section, American Water Works Association and the California Sewage Works Association. The course is being given for one week in the Institute of Government session of the Univer-

sity of Southern California where several thousand city officials and city employees from all parts of Southern California meet for courses along their special lines. The course for water and sewage treatment plant operators has been divided into four joint sessions and two parallel sessions. The general plan is from 8:00–9:00 A.M. daily to have sessions for one week covering general information which both water and sewage operators should know in connection with disease in relation to water and sewage, collection and distribution of water, sewerage works and industrial wastes, substances found in water and sewage and sanitary and recreational use of watersheds and reservoirs. From 9:00–10:00 A.M. daily there will be parallel sessions where the operators are given a review of the processes of treatment for the purpose of enabling them to know what is expected of the type of treatment plant which they operate. From 10:00–11:00 A.M. daily there will be laboratory demonstrations and discussion as well as making of the more common tests used in both water and sewage treatment. From 1:00–2:00 P.M. daily there will be a joint session where operators will be given special instruction on mechanical features such as maintenance of mechanical equipment, shop facilities, operation of electrical equipment, lubrication, painting, beautification of grounds and handy gadgets. From 2:00–3:00 P.M. daily the operators in parallel session will be given detailed information on records of operation, logs, correlation of laboratory data, interpretation of results, and typical routine procedures. From 3:00–4:00 P.M. daily in joint session will be round table discussion on personnel, budgets, safety, meeting emergencies, with the last hour on the final day being reserved for examination. The committee has mimeographed material, which will be used for class lectures and discussions, which has been made into a book of 158 pages. The book sells for $1.00. The plan is to have everyone purchase it and familiarize themselves with the material in it before coming to class for discussion. The cost of the course is $5.00 to those receiving $200 per month or less and $10 for operators receiving more than $200 per month. Already there has been advance notice of heavy registration for this short school. The local committee is also endeavoring to determine whether it will be possible to give a short school in northern California in 1938, taking advantage of federal aid through state universities similar to instruction given to health officers and sanitary inspectors.

CONCLUSION

Licensing in California has gotten off to a good start and is being maintained with high standards. The interest already shown by operators to improve their educational qualifications and their wholehearted support in the idea of certification will undoubtedly lead soon to the committee initiating a vigorous program looking forward to compulsory licensing of all water treatment plant operators, as well as the compelling of all cities having treatment plant operators to employ only those who have been properly certified.

EXPERIENCES IN LICENSING WATER WORKS OPERATORS IN NEW JERSEY*

By Charles H. Capen, Jr.[1]

Much of the credit for the enactment of license law legislation in New Jersey must go to the New Jersey Sewage Works Association. The sponsorship of the State Department of Health was another important factor. A glance at the original (and also the present) membership of the Association, however, will reveal that a considerable number of the active supporters were men who were also vitally interested in water supply, partly because, in many of the New Jersey municipalities, the one in charge of the water supply also supervises the operation of the sewerage system. While the licensing of operators was one of the chief aims of the Sewage Works Association at the time of its formation in 1915, the act did not officially pass until February 9, 1918. In terms of most legislative success along these lines, this was remarkably rapid. Unfortunately the work of setting the wheels in motion to enforce the act, devolved upon the State Department of Health at a time when its personnel was reduced to skeleton proportions by the inroads of the World War. Under the circumstances it was impossible to investigate all of the applications received under the "grandfather clause." In some cases men obtained licenses even though they had never had any real supervision over the plant in question. In other cases more than one license was issued to a plant because the State Department of Health had no method of differentiating between applicants. There were 84 water licenses issued by virtue of the persons holding office at the time of passage of the act.

After the war period the staff and facilities for administering the act were augmented and examinations were held quarterly. Later this was changed to semi-annually. From the start, sewage plant licenses have outnumbered those for water plants by almost two to

* Presented at the Buffalo Convention, June 8, 1937.

[1] Engineer: North Jersey District Water Supply Commission. Formerly Asst. Sanitary Engineer of N. J. State Department of Health.

one. As a result it was necessary to devote the early skeleton staff efforts largely in the direction of the greatest demand. Naturally, therefore, cases existed where candidates for water licenses did not receive all of the attention that might have been desired. More than one applicant presented himself with little more than a hopeful heart and the well wishes of the folks back home. Few of these jobs were considered worth struggling for, because the remuneration, as water works men know all too well, was often woefully unattractive in proportion to the duties and labor involved. The writer, as one of the examiners at the time, was impressed with the extent to which the situation might be developed toward the goal of well qualified operators for all licenses. It must be admitted, however, that the outlook was rather dismal at times with respect to inducements that could be offered to municipalities to employ men either qualified or capable of learning, particularly where the operation of a chlorinator was practically all that was required.

There gradually grew a recognition of desirable improvements to the rules and regulations, formulated under the act to permit successful administration thereof. Decisive action however was not found necessary for some time, culminating in the entire revision of the regulatory measures in 1932. This action was brought about in part by the following: (a) the depression magnified the desirability of positions of licensed operators; (b) the conference between the executive committee of the New Jersey Sewage Works Association and the New Jersey State Department of Health; and (c) the legal establishment of the act by a ruling in the court of Chancery.

On several occasions during the early years, the possibility of firmly establishing the status of the act by resorting to court action was considered and attempted but mitigating circumstances always seemed to prevent a clear cut decision. On June 13, 1931, a decree was handed down by the court of Chancery in which a municipality was definitely ordered to "refrain from appointing any person as superintendent or operator in charge of its sewage treatment plant . . ., who is not the holder of a license issued by the Department of Health of the State of New Jersey." The wording of this decree is decisive and has done much toward inspiring confidence in the act.

Progressively examinations have become more exacting and it seems quite probable that the standard of knowledge required now would be alarming to some of those who qualified in the first two or three years. The situation may be better understood by a study

of the following figures. To date there have been 972 licenses issued, of which 356 were for water operators and the balance or 616 were for sewage plant operators. From this point on the discussion on numbers will be entirely in relation to water licenses only. Of the 356, there were, as stated before, 84 issued under the grandfather clause while the balance or 272 were issued to those passing the examination. The 84 are not distinguishable as to class, but the 272 are divided into classes as follows:

Class	*Number*	*Percent of total*
1st	68	25
2nd	24	9
3rd (prior to July 12, 1932)*	99	36
3rd (Since July 12, 1932)	9	3
4th (Since July 12, 1932)	72	27
	272	100

* Note: Third class prior to July 12, 1932 was in most cases equivalent to the present fourth class. The new third class was previously covered by second class.

Again referring to the 356 water licenses issued, there are 193 in active use at present. There is no method by which the others can be revoked, discontinued or placed in an inactive file. In fact they are just as good and valid as the day they were granted.

Considering the period of 18 years, from 1919 to 1936 inclusive, and dividing this into three intervals of six years each, it is found that in the first six years there were 36 licenses issued after examination and the failures averaged about 5 per cent. During the next six years, 94 licenses were issued and the failures averaged 22 per cent. In the last six year period 131 licenses were issued and the failures averaged 33 per cent. So far in the current year, 11 licenses have been granted with 39 per cent failing. The highest years of failures were 1931 and 1932, being 35 per cent and 41 per cent respectively. Possibly the depression invited many unqualified men in the ranks of the unemployed to take the examination to provide an outlet for possible activities in case they should receive an opportunity for some appointment to a municipal position. Of the 272 licensees, 51 or about 19 percent are college graduates. Regarding qualifications, there seems to be a definite trend toward the offering of a college training for admission to the examination for licenses of the first class. The State Department of Health, however, believes that "the results of the examinations show definitely that a man

having considerable experience, with a high school education, is just as successful if not more so, in passing the examination, as one offering a degree and the minimum required operating experience." Water treatment, being a highly specialized occupation or profession, is an art, the knowledge of which is not entirely confined to ivy covered halls of learning and the situation above quoted seems to bear out the old adage that "there is no substitute for experience."

With the passing of time, the license itself has in many respects become a mark of some distinction. The nuisance factor ascribed to it in earlier days has largely disappeared. In some instances, however, the license has become its own worst enemy. This is more particularly true of sewage plant licenses. An example is one municipality where twelve individuals hold sewage operator's licenses. If the incumbent should make a misstep or for any reason incur disfavor, there would be a stampede for the appointment, with no holds barred. At present there is no method by which multiple licenses can be avoided. The efforts of the various water and sewage associations in New Jersey to overcome this difficulty, as well as to provide tenure of office, have been described in the January (1937) issue of the Journal of this Association (p. 53). No repetition will be given here of the facts brought out in that discussion but it can be reported that certain conditions within the state made it inexpedient to spend the necessary time and effort to try to obtain passage of the bills this year. However the issue is by no means dead and if the proper support is accorded next year, the bills will be offered again. Suffice it to say that no legislation of this kind will be passed unless all the parties concerned put their shoulders to the wheel.

Attention should be drawn to the fact that the existing act and others proposed have been formulated by the men themselves, with the consent and advice of the State Department of Health. The latter body does not seek to dictate what laws should be passed but prefers to act as the administrative agent. However no one need doubt that in respect to the existing act as well as others that may be passed, the department has done and will continue to do its utmost to carry out the spirit and intent thereof.

In conclusion it may be said that the water works and sewage works men have fought most of their battles of the past without much organized support except that of their own making. The increased activity of this Association in the last few years has acted as

a stimulus of no small measure. The water men are deeply appreciative of the coöperation of the Association both from a national and sectional standpoint. To what extent it may be possible, an even more closely knit coördination of effort between the Association and the license conducting agencies of the various states will undoubtedly be welcome and helpful.

Acknowledgement is here given to the coöperation of the Bureau of Engineering of the New Jersey State Department of Health, which kindly supplied the figures used in this discussion.

REPORT ON INDIANA DISTRICT MEETINGS*

By Paul C. Laux[1]

During the past three years, the Indiana Section has conducted district meetings for Water Works Superintendents and operators. These gatherings were sponsored with the cooperation of the Indiana Division of Public Health and Purdue University. The object has been to reach the operators of small plants, who did not attend the state meetings of the section, and to have explained in elementary terms every day problems of water works operation and maintenance.

In 1935 the state was divided into eight districts, of which two were later consolidated, so that seven meetings were held. In 1936 it was decided to hold but four meetings. The result was that the total attendance dropped from 213 to 138. For 1937 the State was divided into six districts and the total attendance rose to 255.

In 1935 there were 281 public water supplies in Indiana of which 77 or 27½ percent, were represented at those gatherings, while in 1937, the number of supplies had increased to 301, of which 88 or 29 percent were represented. The attendance of superintendents and operators for the three year period was as follows:

1935—135; 1936—102; 1937—173.

The State Division of Public Health has prepared the table on page 1106 on the attendance at the meetings over the three year period.

This table shows conclusively that these meetings must be held in relatively small districts, so that water works men can get back and forth without too much driving. It also shows an increase in attendance for 1937 over 1935, which cannot be entirely accounted for by the increase in the number of water supplies in the state. Part of it is probably due to an increase in interest on the part of

* A report to the President of the Indiana Section by the Chairman of the Section Committee on District Meetings.

[1] City Chemist, Anderson, Indiana.

Summary of attendance at Indiana operators schools

CITY	YEAR	NUMBER OF SUPPLIES IN DISTRICT	SUPPLIES REPRESENTED AT MEETINGS	SUPERINTENDENTS AND OPERATORS	CLASSIFICATION			TOTAL ATTENDANCE
					Other City Officials	Professional Men	Manufacturer's Representatives	
South Bend	1935	88	17	33	8	4	8	53
Purdue University	"	48	9	10	1	6	2	19
Anderson	"	44	7	15	0	4	3	22
Batesville	"	25	7	13	1	5	1	20
Terre Haute	"	27	9	12	1	5	0	18
New Albany	"	25	15	30	3	6	2	41
Evansville	"	24	13	22	6	11	1	40
Total		281	77	135	20	41	17	213
Michigan City	1936	—	—	25	5	4	0	34
Kokomo	"	—	—	20	0	5	0	25
Washington	"	—	—	30	8	6	2	46
Columbus	"	—	—	27	0	6	0	33
Total				102	13	21	2	138
Huntington	1937	64	19	39	3	3	17	62
LaPorte	"	59	10	17	3	6	2	26
Lebanon	"	50	15	25	2	2	2	31
New Albany	"	27	12	34	1	5	3	43
Shelbyville	"	64	11	16	1	2	1	20
Vincennes	"	37	21	42	3	8	18	71
Total		301	88	173	13	26	43	255

water works men, and part to the honest effort of the committee and of the chairmen of the district meetings.

The meetings are conducted mainly on the principle of informal papers and round table discussions. Subjects for discussion are determined as follows:

1. A long list of possible subjects is submitted to the entire attendance, at the annual convention of the state section with the request that each man mark the subjects he would like discussed at his district meeting.

2. This poll is submitted to the committee on district meetings and tabulated by them, with the number of votes for each subject.

3. Those subjects with the highest number of votes are listed and a list sent to each district chairman. From this list the chairman prepares his own program and also selects speakers for the program. He is aided in this work by the committee and the State Division of Public Health.

The following is a list of subjects submitted to the district chairmen for the 1937 programs.

1. What should the State Board of Health mean to you?
2. Main flushing.
3. Round table discussion on operating problems.
4. Selling your Water Works.
5. Sterilization of mains.
6. Chlorination for small plants.
7. Tastes and odors and their control.
8. Well location and construction.
9. Laboratory control for water supplies.
10. Repairs to valves, meters, and mains.
11. Distribution system records.
12. Coagulation tests—What they mean.
13. Cross connections.
14. Waste water surveys.
15. Efficient operation of pumps.
16. Paints.

The committee has at times felt discouraged by the small attendance and the lack of active participation in round table discussions. However, we feel that we have made a good start in the right direction, and that this year's meetings have shown a decided improvement over those held in previous years.

IN-SERVICE TRAINING PROMOTED BY STATE LEAGUES OF MUNICIPALITIES*

By C. W. Ham
(Executive Director, American Municipal Association)
(Chicago, Illinois)

The New York State Conference of Mayors and Other Municipal Officials made the first notable contribution to league in-service training by establishing a zone training program in 1928 for policemen and firemen. At that time the Conference had had extensive experience in providing municipal officials with accurate and complete data on municipal practices through its own effective information bureau. "A study and observation of municipal administration," says the Conference, "revealed a few years ago that the goal of perfection sought was not being approached as rapidly as the public demanded and the Conference desired. It was found that municipal service was greatly improved but that municipal servants were not uniformly proficient, and the Conference had been exerting all of its energies to aid officials to solve problems and establish policies as they arose. Practically nothing had been done to help the new official know his job. Experience had been teaching the official the daily routine of public service, and although experience was a competent and exacting teacher it was also slow and expensive. The problem, then, was to find an effective substitute for experience during the apprenticeship period. Close study brought the solution. That solution is the municipal training school which provides training in service."

After two years of valuable experience in its police and fire training programs, the Conference expanded its program in 1930 to include training for financial officials, civil service commissioners, building

* Portions of a dissertation entitled "Toward Competent Government." The major part of this document has already been published in this Journal (Vol. 29, p. 111, 1937). The material herewith presented was omitted at that time so that it might be included in this issue of the Journal which deals so extensively with water works short schools and licensing of operators.

inspectors, and welfare officials. So successful was the training program that its further expansion was inevitable. This expansion was made possible when on January 1, 1931, a grant of funds was received for this purpose to be used over a six-year period.

Since that time, except for 1933 when all save police and fire schools were suspended because of the municipal financial crisis, the training program of the Conference has been steadily expanded. All in all, the Conference has now operated more than 300 training schools which have been attended by more than 47,000 municipal officials in New York State. The training program of the Conference has several significant characteristics. To begin with, it is under the control and direction of municipal officials themselves. Secondly, it places upon municipalities the responsibility gradually to assume the cost of training. Finally, while "the training is not yet a requirement, it is available only to officials in the service. As the plan develops training undoubtedly will be necessary for advancement, if not compulsory for permanent tenure. Already in several New York municipalities police and firemen seeking promotion find themselves handicapped if they have not attended the training school. In those municipalities the state and local civil service commissioners are allowing certain credits for attendance at the training schools of the New York State Conference of Mayors and Other Municipal Officials."

Following closely in the footsteps of New York, the League of Virginia Municipalities in 1932 established a zone training program for police and in 1933 a fire zone training program.

Some idea of the way such a program operates may be obtained from the following brief description: "Zone fire training schools for firemen, paid and volunteer, were inaugurated in Virginia in 1933, when the first Instructors' Training School was held at Richmond. The locations of zone schools at comparatively equidistant points were determined having regard to density and geographical distribution of the population and the distance to be travelled by the students to the zone centers. Twenty-four zone centers in all were established, from each of which a competent, experienced fireman, with potentialities as an instructor, was chosen after conferring with fire chiefs, managers, mayors, and officers of the various associations and organizations sponsoring the training program.

"Each year, the zone school instructors have been brought to Richmond for one week of intensive work designed to

equip them as fire instructors, after which they have returned to their respective communities and in coöperation with the staff of the League of Virginia Municipalities have organized and conducted zone fire training schools for the members of their own fire departments and those of neighboring communities in each zone. The fire departments adjacent to the zone training center usually sent their members to the instructors. In a few instances, however, the zone instructor organized branch schools in various sections of his zone. Under certain conditions, the latter plan is advantageous, although it is more costly and requires much more time on the part of the respective instructors."

The training program of the Virginia League has likewise expanded since its inception, and has reached more than 9,000 municipal officials in the state.

Following the example of these two states, training schools in one or more of the past five years have been held under the auspices of state leagues of municipalities in Arkansas, Colorado, Georgia, Illinois, Indiana, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, Ohio, Oklahoma, South Dakota, Tennessee, Texas, Washington, West Virginia, and Wisconsin. The number of municipal officials reached by these programs was approximately 7,000 in 1931 and has risen steadily until in 1936 the total attendance was approximately 14,000.

THE EFFECT OF FEDERAL LEGISLATION ON THE RETIREMENT AND PENSIONING OF WATER WORKS EMPLOYEES*

By Dale L. Maffitt[1]
(*Chairman, Committee on Social Security Legislation*)

The importance of old age retirements or some adequate system of pensions has been shown in the past by the ills of periodic business depressions. "Saving for one's old age" has long been a by-word of the American employee, whether he be the unskilled workman or the high business executive, but the rhythmic rise and fall of business activity in what is known as the business cycle has always made planned saving difficult for the small wage earner.

This has been especially emphasized in the far-reaching effects of the recent business depression which started its downward trend in 1929. The swift collapse of the general economic structure and the slow process of recovery wiped out the accumulated savings of thousands upon thousands of old people, leaving them dependent for the rest of their lives on charity or organized assistance from the government. The younger man who was sacrificing present wants for an anticipated future security has seen his savings evaporate in thin air and has been forced to accept government aid along with his less provident neighbor. The result has been a general discouragement of saving from an individual point of view, and members of the younger generation are taking the attitude that they had better spend their money while they have it.

The growing magnitude of the industrial system and man's dependence on a social group is making it more and more evident that some provision must be made for adequate support of employees after they reach old age. The assurance that the employee who has rendered a faithful service through the productive years of his life is to receive a comfortable income after retirement will relieve the employer of any embarrassment at having to discharge him when he gets too old to do effective work.

* Presented at the Buffalo Convention, June 8, 1937.

[1] General Manager, Water Works, Des Moines, Iowa.

Many business institutions and professions and some departments of the government have had a more or less adequate system of old-age pensions for a long time, but in the most part provision for old-age retirement has been an individual thing.

If during the last 50 years every employee had followed a general program of systematic saving, laying aside with an insurance company a stated amount out of each pay check, much of the suffering of the last eight years could have been avoided. We mention insurance because it has long been recognized as the most conservative and practical method of saving. Regulation of classes of securities in which insurance reserves may be invested has resulted in the growth of many strong and financially sound companies. It is also a method of saving which permits the laying aside of small amounts each month. However, the great mass of the laboring population has not taken advantage of this method of systematic saving.

The economic developments of the last few years have forced the general public to become conscious of the need for some method of old-age retirement. The result has been enactment of federal legislation incorporated in the "Social Security Act," approved August 14, 1935, and becoming effective January 1, 1937. The law is designed to provide some safeguard for the individual and family against the insecurity of modern life through coöperation between the federal and state governments. The provisions of the act deal with a number of measures relative to social security, one of which is a pension plan for employees not over sixty years of age at the date the law goes into effect.

However, certain groups of employment are exempted from participation in the Social Security Act. Section 210 (b) (6) states one of these exemptions to include "Service performed in the employ of a state, a political subdivision thereof, or an instrumentality of one or more states or political subdivisions." This provision of the law excludes water works employees from participation in the old-age benefits under the act insofar as water works companies are municipally owned. Since approximately 82 percent of the cities in the United States of more than 10,000 population own the water systems operating within their limits, for the purpose of this discussion we shall assume that employees of water works organizations are not eligible to participate in federal old-age benefits. This puts them at a disadvantage, as compared with employees of industrial concerns.

In order to understand just what the federal social security legislation is offering to industrial employees, we wish to refer briefly to that section of the Social Security Act which has to do with old-age benefits. The act provides two distinct measures for old-age security.

The first, under Title I of the act, has to do with old-age assistance. This is gratuitous aid in cash given to old people without other means of support, and paid from general taxes without contributions from the beneficiaries. Old-age assistance is administered by the states, the federal government merely giving financial aid to the states for part of the costs, provided the states comply with certain standards of administration and regulation as to eligibility set forth in the Social Security Act.

Title II of the act has to do with old-age benefits. Under this plan regular benefits are paid to qualified individuals out of an "old-age reserve account." These benefits are in effect a right and not a gratuity, and have no reference to need. Qualified beneficiaries will be subject to special taxes which are expected to finance part of the costs. A qualified individual is one who is at least 65 years of age, who received total wages with respect to employment after December 31, 1936, (and before attaining 65 years of age) of not less than $2,000.00, and who has been employed in some five different calendar years after December 31, 1936, before attaining the age of 65 years, and whose wages do not consist of remuneration from certain exempted occupations, including in our analysis water works organizations. The minimum monthly benefit payment is $10.00 and the maximum $85.00. Benefits vary with the amount of wages received. Workers who have received less than $2,000.00 in total wages and whose employment falls in less than five different calendar years will, upon reaching age 65, receive a lump sum equal to 3½ percent of their wages for included employment.

Benefit payments are to be made out of an "old-age reserve account." The act authorizes Congress to appropriate each year an amount sufficient to provide for the payments required. The old-age benefits are administered directly by the federal government, the states having nothing to do with their cost or administration.

Title VIII of the act is connected in the popular mind with the old-age benefits referred to under Title II. Title VIII imposes two distinct taxes, payable into the treasury of the United States,—an income tax on employees measured by wages paid them, and

an excise tax on employers measured by payrolls. The employees taxed are the individuals to whom benefits will be paid under Title II. For the first three years the tax is 1 percent on employee and 1 percent on employer, excluding any excess of $3,000.00 paid to one individual in a year. In 1940 the tax increases by one-half of 1 percent and every three years thereafter until the maximum rate of 3 percent on both employee and employer is reached in 1949. These taxes are generally regarded as the source of revenue for the building up of reserves for payment of old-age benefits referred to under Title II. However, the legal responsibility of keeping the reserve fund adequate depends on Congress.

The states in general have not met the problem of retirement insurance. Certain groups of municipal employees have long been protected by old-age pensions. Retirement systems for firemen and policemen are almost universal. These pensions are based on merit and period of service. Teachers' organizations have succeeded in establishing pension plans in many school systems. These plans are confined to small groups and are not generally standardized by state legislation.

The recent federal social security legislation has stimulated public sentiment in that direction and many groups which are not covered by the old-age retirement provisions of the Social Security Act are formulating plans for their own protection.

A bill for pensioning of Iowa public school teachers was introduced recently in the Iowa legislature, but failed to pass. School administrators have not given up the idea, however, and are working to perfect the plan, in the hope that it may be passed in the next General Assembly.

It is suggested by those opposing the Social Security Act that such a step would place the Federal Government in the insurance business and in this manner compete with insurance companies to the extent that the future insurance business as a whole might be jeopardized. Further analysis of the problem, however, seems to show that there is little danger that such will be the case. As stated above the great mass of the employees of industry has never acquired the habit of taking so much out of its pay envelope each week, and it is largely this group that the social security law is designed to benefit.

The old-age pension system of the Social Security Act is a compulsory annuity program. It is an attempt of the Government to regulate saving habits of people of the United States employed in industry, through definite and systematic taxes on payrolls. It is

an endeavor to help workers to protect themselves, with the aid of their employers, against the economic insecurity of old age. The Government will force saving by its method of administering the Social Security Act.

Industrial pension plans already in existence have been converted into plans supplemental to the federal plan. Edwin E. Witte, of the University of Wisconsin, writing on old-age security in the Journal of Political Economy, February 1937, states that the Social Security Act has operated to give a stimulus to the establishment of new industrial pension plans. He says, with reference to the effect of recent federal legislation, "at no time has the volume of new business done by insurance companies been as great as during this period."

Mr. Leroy A. Lincoln, President of the Metropolitan Life Insurance Company, thinks that the Social Security Act will stimulate rather than retard saving. In an interview for publication in Scholastic magazine, April 10, 1937, Mr. Lincoln was asked what effect he thought the Social Security Act would have on the business of the Metropolitan Life Insurance Company. He replied, "We anticipate that the act will have no adverse effect on the thrift habits of individuals, but will rather stimulate them. Savings banks, life insurance companies, and similar institutions will continue to provide the individual with a way to make provision beyond the minimum of public plans, and more adequate and more appropriate to his own desires."

The problem before us is what effect federal legislation has had on the retirement and pensioning of water works employees. We see that where water works organizations are owned and operated by municipalities their employees are not directly affected by the recent federal legislation. They are not eligible to participate in benefits as are those employed in private industry. Water works employees want and need security just as much as employees of any other group. Those in charge of the management of water works organizations are becoming more and more aware of this need, stimulated no doubt by the recent social security action. As time goes on and benefits accrue to employees retiring under the Social Security Act, water works employees are going to insist that some plan be devised whereby they may enjoy the same privilege of security that the industrial worker has been granted, assuming of course that the Social Security Act does what it is designed to do.

It is generally agreed that employers should contribute some-

thing to the costs of retirement allowances. No question is raised regarding charges for depreciation on machinery and equipment. A charge for the depreciation of the labor element is just as important. With a retirement system under which both worker and employer contribute, employers may humanely replace, with younger men, older employees who have become unproductive. The older man will be glad to retire because, having independent means, he will not have to eke out a meager existence living on the charity of children or state.

Many industrial concerns have recognized this need and have organized their own pension systems. The American Telephone and Telegraph Company and the United States Steel Corporation are examples. It seems self-evident that some plan should be devised for the retirement of water works employees on a pension that will permit them to live their unproductive years in comfort. Water works organizations supply a public need, and the employees of a public utility render valuable service at an average wage, and are conscientious individuals employed for ability, quite often rendering faithful service over a long period of years. It seems the just and ethical thing that the organization should provide some plan of retirement for them.

If water works employees are to have an old age retirement system it must be organized either as a plan in each individual company, or as a group plan for the Association as a whole. This might be done by building up reserves in each individual company, or by building up a joint reserve in the Association, or through an insurance company. In any case the plan should be based on the best actuarial statistics.

This is a period in industrial development in which social security is receiving special attention. The Federal Government has assumed the burden of old-age benefits for the great mass of employees in private industry. But those certain groups which are not covered by the federal legislation must organize their own program. It seems to us to be a problem which water works executives are obliged to meet.

PUBLIC EMPLOYEE PENSION SYSTEMS

By L. A. Smith
Superintendent Water Department, Madison, Wisconsin

With the passage of the Social Security Act old age benefits are provided for all employees in private employment in the United States. In Wisconsin, the employees of the police and fire departments have had a pension system under the Wisconsin statutes for a good many years. This pension system provides for a 1 percent contribution on the part of the employees, the balance to be made up by various special revenues and such tax monies as are necessary. Among these special revenues is 2 percent of the premium paid on fire insurance policies and all rewards and donations earned by policemen and firemen in the performance of their duties. A man is eligible for pension after 22 years of service and the pension which he receives is 50 percent of his final wage, with special provisions for taking care of widows and orphans. This is a very generous system but cannot be used as a basis for general pension systems as the cost from tax monies would be prohibitive.

The public school teachers in Wisconsin also have the Teachers' Retirement Law which provides a pension for such teachers. The teachers contribute 5 percent of their salaries and the State contributes 5 percent, raised through a surtax on incomes. This money is invested by a special board set up in Wisconsin known as the Annuity and Investment Board.

With the policemen, firemen and the school teachers provided with pension systems there is a minority group of city employees who are not eligible for pension under the Social Security Act, nor any state authorized system—among these are water utility employees.

While the State of Wisconsin has as yet no pension system for state employees a bill has recently been introduced into the Wisconsin legislature providing for such a system. This is based on employees' contributions beginning at 2 percent of their salaries for the first year and increasing 1 percent per year until the employees will contribute 5 percent of their wages, the maximum contribution being

$10.00 per month. The State will contribute from the very beginning 5 percent of the wages, not to exceed $10.00 per month for any individual employee. The pension to be paid will be $3.00 per month per year of service. This is based on twenty years of service so that the maximum pension available would be $60.00 per month. The retirement age has been fixed at 65, although an optional retirement age at 60 is provided, with correspondingly reduced pensions. There are involved in Wisconsin nearly 6,000 employees and the annual amount which would have to be appropriated by the State to meet its share of the pension system would be $710,000.00.

I have been interested in pension systems for water works employees for over ten years because I feel that the adoption of pension systems definitely raises the morale of employees, increases their effectiveness because of less worry over old age and decreases labor turnover because a pension provides benefits which employees do not readily discard for opportunities which provide for only a small increase in wages.

In discussing this matter with the city administration it was agreed that all departments should be provided for, but the laws in Wisconsin are such that there is a different legal status as far as water utility employees are concerned as compared with other city employees, because all city employees, except water department employees, are paid from tax revenues. In view of the fact that enabling legislation was necessary to provide a pension system for city employees other than water utility employees, it was felt that the water department should make a study and install a pension system which could subsequently be extended to cover other city employees not now covered as soon as the necessary enabling legislation was adopted. Incidentally, such legislation has been introduced at the present session of the legislature and probably will not meet with any serious opposition.

During the year 1936, a comprehensive study was made of pension systems with special reference to the situation existing in Madison. Certain basic facts were ascertained. While there are a large number of pension systems in the United States they fall into two general classes; first, pension systems based on life insurance and second, pension systems based on private investment of pension funds. Both of these classes have two general subdivisions—(a) pension systems entirely supported by employee contributions and (b) pension systems supported by joint contributions of both employer and em-

ployee. Our studies indicated that with practically no exceptions pension plans based upon life insurance companies investing the funds were still in effect, whereas, we found that a large number of those pension systems based on private investment of funds had been liquidated during the last five or six years due to investment losses. It seemed, therefore, desirable that the pension system we adopted should be based upon an insurance company investing the funds. The proper social viewpoint of the responsibility of the employer indicated that the employer should also contribute to the fund as, unless this was done, the only advantage which would accrue to the employee was the advantage of group insurance.

One of the first questions which arose was what the amount of the pension should be and what the ordinary employee should be expected to do for himself during the period of his employment. It is very difficult to make a complete and adequate determination of these points but we finally concluded that an employee should be expected to acquire a home during the period of his active employment and that if he did this we felt that a pension of approximately 50 percent of his final wage should enable him to live from the age of 65 until his death without serious financial problems. It was found that if we assumed joint contributions on the part of the employer and the employee of equal amounts over a period of 25 years, that a pension of approximately 50 percent of the final salary could be secured at an annual cost of about 7 percent of the pay roll. This would mean that both the employer and the employee should contribute an amount equivalent to 3½ percent of the employee's salary.

In any organization employees over the age of 40 are generally the key men and the most important to the organization. It seemed inadvisable, in spite of the fact that these men would reach the age of 65 before they had contributed 25 years to require them to retire on a pension less than younger employees would receive. For this reason the water department will purchase past service benefits so that the pension for such employees will be based on 50 percent of their earnings for the last 20 years of service. When the time comes that all employees have been retired who have contributed less than 25 years, the contribution of the employer and employee will be approximately equal, but prior to that time the employer will be required to invest an amount considerably in excess of the amount contributed by the employees.

On December 9, 1936, the Board of Water Commissioners of the

City of Madison definitely adopted a pension system for water department employees, the system to become effective on January 1, 1937. In its essential features the pension system has the following provisions:

1. Pension payments are to be made monthly beginning on the first day of the month following the attainment of the age of 65.

2. For each year of membership the contributing employee will receive an annual pension of 2.5 percent of his salary during such year.

3. The employee's contribution will be 3.5 percent of his salary.

4. Each employee between the ages of 40 and 45 will contribute for 20 years, and the annual pension will be 2.5 percent of the salary earned during this 20 year period.

5. Each employee under 40 years will contribute for 25 years and the annual pension will be 2.5 percent of the amount earned during this 25 year period. The reason that we selected a 25 year period is that younger employees should contribute for a longer period in order that their pension will be essentially 50 percent of the final salary. In the case of younger employees lower wages are received in the earlier years of employment which would make the pension less than 50 percent of the final salary if contributions were made only over a period of 20 years.

6. As stated above, the water department will purchase past service benefits so that the pension received will be 50 percent of their earnings during their last 20 years of service.

7. The contribution of the employee will be returned to him, with interest if he leaves the department before the age of 65. If he dies it will be returned to his stipulated beneficiary.

8. The pension will affect all water department employees who are paid on a monthly basis who have not attained the age of 65.

At the present time there is a total of 46 employees in the water department of which six are over the age of 65, so that 40 are affected. In the case of those over 65, it is the intention of the water department to assign such easier, or part time work as seems consistent with their physical condition, and to give them such special consideration as the facts of their employment justify.

The monthly contributions of the employees affected in the amount of 3½ of their salaries amounts to approximately \$250.00 per month, and the contribution of the water department at the beginning will amount to approximately \$970.00 per month. This contribution on

the part of the water department will be materially reduced when past service benefits are paid up, which will be at the end of 16 years, and will be further reduced as employees over the age of 45, at the present time, are retired.

In considering this matter from its legal aspect, we find the following facts: The Board of Water Commissioners has the right and authority to fix wages of all water department employees, and nothing is stated in the law as to when and how such wages are to be paid. The water department adopted a resolution fixing the wages, including the pension system. The resolution is as follows:

> "*Resolved*, that the salaries and wages of the water department employees, employed on a monthly basis and not over the age of 65, be fixed at the sums included herewith, being the amounts placed in the 1937 budget, less a reduction of 3½ percent, these amounts to be deducted monthly plus a pension based upon 50 percent of their average wages to be paid at the attainment of the age of 65. The terms and conditions of said pension system are to be fixed by the Board of Water Commissioners and may be modified, from time to time, as deemed necessary, with the specific understanding, however, that in every case the employee will be entitled to receive the full amount of his, or her contribution, plus interest earned. In case of death the amount above mentioned is to be paid to the selected beneficiary."

There are several optional features which are available to the employees. If the employee desires to retire at the age of 65 he may do so. If the department desires to retire him at the age of 65 it may do so. However, if both the employer and the employee agree that employment should continue, this may be done. In this case the employee will receive his regular pension from the Insurance Company and the City will pay the difference between the amount he receives as a pension and the amount to which the department feels he is entitled. In case employment is continued after the age of 65, the pension contribution on the part of the employee will stop. Other options are as follows:

1. The employee who leaves the service before retirement may elect to have his contributions returned, plus interest earned, or he may leave his contributions with the Insurance Company to provide a pension commencing at the normal retirement age.

2. If no option is exercised the employee will receive the regular pension provided by the plan, which pension ceases with the last

monthly payment prior to the employee's death. If an employee desires to protect his investment, he may elect to receive a slightly reduced pension, payable as long as he lives, with the further provision that if he does not live to receive an aggregate amount equal to his contributions, with interest earned to the retirement date, the unpaid balance will be paid to his beneficiary.

3. He may also elect to provide for the support of a dependent after his death by taking a reduced pension while he lives, which will be continued after his death, during the remaining life of the beneficiary named by him.

4. He may also retire before the pension age. The contract specifically provides just how the computations are to be made in case of the employee exercising any of the options.

An extremely desirable feature of the pension system would be the inclusion of life insurance in the amount of $500.00 or $1,000.00 to be paid to the beneficiary at death if death occurs before the age of 65. This provision was not adopted because of the cost. I believe that such a provision might well be included if finances permit and it may be adopted in the case of our pension system after the past service benefits are paid up.

I believe that the universal adoption of pension systems by municipal organizations is a definite step in the right direction because freedom from worry about old age will be largely eliminated, labor turn over will be materially reduced and the morale of the organization will be kept at a higher level. There is a definite question in my mind as to whether or not employees of municipalities will ever be permitted to receive the benefits of the Social Security Act. As the law is now constituted, they are not eligible and the factors which governed Congress in making this provision originally, may be such as to prevent its being changed by later legislation.

VALUE OF THE MANUAL OF WATER WORKS ACCOUNTING*

By Carl H. Chatters

(*Executive Director*)

(*Municipal Finance Officers' Association*)

(*Chicago, Ill.*)

People do not get typhoid fever if your water works accounting is poorly done. If they did, you would give the water works *office* the same attention you give the *filter plant*. People may not die through faulty fiscal management, but the water plant itself may deteriorate and the city may spend large sums unnecessarily for its operation, maintenance, and extensions. And so the immediate purpose of the finance and accounting division is to produce a manual of water works accounting procedure that will be generally useful to the greatest number of your members.

The preparation of this manual is a joint enterprise of the Municipal Finance Officers' Association of the United States and Canada and the American Water Works Association. The job was undertaken jointly because of your interest in water works accounting and because of the general and continuing interest of the Municipal Finance Officers' Association and the National Committee on Municipal Accounting in the general subject of accounting and finance. The two associations are working together on the project and are to share equally in the work, the credit, and the benefits resulting therefrom.

One may ask how the enterprise came about. The Municipal Finance Officers' Association and the National Committee on Municipal Accounting have for three years been working toward the development of general municipal accounting standards. The association was receiving frequent requests from its public official members for information about water works accounting systems. It therefore decided to go ahead with the preparation of a manual. About that

* Presented before the Finance and Accounting Division, June 8, 1937.

time I realized that the American Water Works Association had at least an equal interest in the subject. Accordingly, contact was made with Mr. Hal F. Smith of Detroit, the chairman of your division. He immediately expressed considerable interest in the project on behalf of your association. After a few weeks of preliminary negotiations with your division and your general officers, a written agreement was entered into on the basis of which the studies are now being conducted.

Mr. Charles T. Sweeney, C.P.A., now of Springfield, Ohio, was retained to serve as technical consultant of the joint enterprise. He was selected because he had already developed in the state of Iowa a comprehensive manual of utility accounting along similar lines. For the past six months he has been working actively in coöperation with the representative committees of the two associations involved.

You may perhaps get a better view of the importance of this project and the value of developing it as a joint product if you understand a little bit more about the National Committee on Municipal Accounting. That group was organized in January, 1934, to represent the four leading professional accounting societies of the United States, four national groups of public officials, a national citizens' agency, and the United States Bureau of the Census. A central committee of ten persons controls its policies, subject to the more intimate direction of an executive committee of three. Then, each association represented on the central committee has its own special committee on municipal or governmental accounting. During the period of its existence the committee has developed the following publications: *Suggested Procedure for a Detailed Municipal Audit; Municipal Accounting Terminology; Municipal Funds and Their Balance Sheets; Municipal Accounting Statements;* and *Bibliography of Municipal and State Accounting.* It is now engaged primarily in promoting into actual use the standards it has developed. Some idea of the standing of the committee's work may be found in the fact that its publication *Municipal Accounting Statements* was given the award as the outstanding accounting publication of 1936 by Beta Alpha Psi, leading national honorary accounting fraternity. The committee has succeeded because it was a joint enterprise, because it had a full time staff, and because it has realized the necessity of promoting into use the standards it has developed.

Part of the basic material necessary for uniform utility accounting already exists. This has been brought about largely through the

efforts of the National Association of Railway and Utility Commissioners. It must first be recognized that the essentials of uniformity are an accepted classification of accounts, the use of a common terminology, and the consistent application of similar accounting principles. There is quite general agreement on the question of the classification of water works accounts through almost universal adoption of the classification of the National Association of Railway and Utility Commissioners or some slight variation of it. There is far from general agreement among you on terminology. This subject has not been treated at length by the National Association of Railway and Utility Commissioners, which merely describes accounts but does not often define terms. You are not at all agreed, at least in practice, on the accounting principles relating to such things as valuations, depreciation, rate schedules, what constitutes cost, and cash versus accrual methods of accounting. There are scores of other principles on which there is no general agreement. Accordingly, although you do agree on a classification, you will never have comparable information until you have more fully agreed on terminology and quite fully agreed on basic utility accounting principles.

The proposed manual of water works accounting will tell *how* to do the job. We may liken the procedure to a doctor who, as a pre-medical student, studies chemistry, botany, zoology, anatomy, and languages. After studying these things he still has to learn how the human body works. Now, you have learned many things about classification, about terminology, and something about general accounting principles. Through this manual we hope that water works accountants generally may be able to see better how the accounting system works, how to take it apart, and how to put it together so that it will function smoothly.

The proposed manual will be generally applicable to water plants in cities of 5,000 to 100,000 population. It will be adaptable both upward and downward. It was aimed primarily at cities below 100,000 population because there are only ninety-four cities in the United States larger than this and there are thousands much smaller. Work along similar lines has been done in other fields. Much was done in private industry under the codes of the late lamented NRA. Perhaps the best accounting manual I have ever seen for directness and simplicity of application was that prepared for the Retail Lumbermen's Code Authority. Another example is the manual of

accounting for Virginia counties prepared by the state auditor of that state. Specific cost accounting manuals for public works activities were prepared by one agency for cities of various sizes, including Albert Lea, Minnesota, Kenosha, Wisconsin, Brunswick, Georgia, Flint, Michigan, and Cincinnati, Ohio. The Municipal Finance Officers' Association, coöperating with the League of Minnesota Municipalities, prepared two accounting manuals for small cities in Minnesota, and is now undertaking manuals on a state-wide basis in five other states. Scores of cities have adopted the standards of the National Committee on Municipal Accounting and are now preparing their reports in line with its suggestions.

It appears to me that water works accounting practice is in general far ahead of general municipal accounting. However, I would say that general municipal accounting at this time is making more rapid progress than water works utility accounting.

When the water works accounting manual has been completed the job is only started. The manual must be placed into daily use by those water plants which need to overhaul their accounting and office practice. This will serve to give your division of the American Water Works Association a definite program for many years to come. You can strengthen the work of this division by looking at accounting from its administrative use and its human aspect. The facts you record on your books take on their greatest value only when translated into reports on the basis of which someone can take action. Otherwise accounting is mere bookkeeping, a static, dead thing; a pale, lifeless corpse. But in the form of timely, well kept, comparative reports, accounting takes on value for owners or citizens, for water plant operators, and most of all, for those who perform what would otherwise be a dull and uninteresting task. It is the duty of your division and of others interested in proper administration to help develop, to help humanize, and then to put into actual use the type of records that will really have some value.

THE PREPARATION OF A MANUAL OF WATER WORKS ACCOUNTING PROCEDURE*

By Charles T. Sweeney, C. P. A.[1]

Some time ago it was intimated to me by a state official of a western state that the accounting methods of water utilities left a great deal to be desired; that many actions of management were based on surmise and upon inadequate records. This man also intimated that undoubtedly the action of water works executives in many cases would be different if more accurate information were available. Since the man had some responsibility for the accounts of municipal utilities he was in possession of first hand information. If this person's reactions were accurate it could only mean that the records were inadequate in some respects. When I started to prepare the Manual of Accounting Procedure for Water Works this earlier information was confirmed.

When it was definitely decided that I was to proceed with the preparation of the preliminary draft of a manual for water works accounting procedure, it became necessary to set a definite aim for the project, which, when reached, would provide a basis for the correction of accounting deficiencies as they seem to exist. The field toward which the project was directed was delimited. It was to be particularly directed at water works plants in cities from 5,000 to 100,000 in population for the reasons which have been described. The manual was further circumscribed by excluding any classification of accounts since a widely adopted classification was already in use. While this classification has certain deficiencies, it does offer a much used base upon which to build. In the use of illustrative entries it is desirable that exact account titles be used whenever possible. The account titles in widest usage come from the classification of the National Association of Railroad and Utilities Commissioners.

Since the base for accounting records is already in existence, why has it not been used to a greater extent? Why did it not produce

* Presented before the Accounting Division, June 8, 1937.

[1] Chief of Technical Staff, Manual of Accounting Procedure for Water Works, Tecumseh Building, Springfield, Ohio.

more desirable results? Apparently there is no single answer to these questions. The general conclusion can be reached that, while a base for accounting records was available, there has been no simple authoritative guide to the building of good records upon this base. General rules and directions, such as appear in utility manuals, may be made the basis for discussion, but to one not strongly steeped in accounting theory and practice they represent no answer to a bookkeeper's specific questions. The manual, then, has to be a simple, but clear and specific, set of directions for the average bookkeeper whose duty it is to record the daily transactions—something to which the bookkeeper can turn when in doubt.

The next step, after the general scope and aim of the manual had been decided upon, was to investigate accounting literature in the water works field and the problems occasioned by different methods of operation and types of ownership. Since it took considerable time to accumulate the literature, the first actual step toward completion of the manual consisted in visiting various water works plants which might be regarded as typical. This acquainted me at first hand with different technical processes and problems of different administrative setups. It also provided me with a considerable number of contacts with individuals who could be counted upon to advise and further the project and who furnished many typical accounting forms. I am very grateful for the courtesy and help which I received, both then and later, from the plants visited.

Many agencies, including various state public utilities commissions and service agencies to the industry, contributed their literature. The American Water Works Association made available many reprints of convention addresses on accounting subjects, many copies of its official Journal, its Water Works Practice Manual, and placed my name on the subscription list of its Journal while the manual is being prepared. My visits and an examination of this literature and of accounting texts in both the field of general accounting and public utility accounting have given me some idea as to the problems of the industry. They have given me definite ideas as to the ground to be covered in the manual and how it may be covered.

One conclusion I reached is that, with respect to the accounting for purely operating activities, there is no difference between the private and the municipal water works. Such differences as there may be from the different types of ownership have to do primarily with ownership equity accounts. This part of the accounting is relatively

simple and clear cut. There is, of course, some difference involved in rate making on a scientific basis, but this is a difficult subject in itself and one with which we are not directly concerned in this manual. Rate making will be discussed in the manual only insofar as it pertains to the securing and handling of basic accounting information.

From an examination of the manuals of the various states I have also reached the conclusion that the public utilities commissions are primarily concerned with accounting records which will enable them to carry out their supervisory function in a better manner. They should be directly interested in accounting records which will enable local water works executives to better perform their functions. I do not wish to detract in any way from the work of the various state commissions. They have contributed more than any other agencies of which I know to uniformity of accounts and accounting. I do believe, however, that they would have accomplished their primary object, and at the same time have greatly furthered good accounting records, if they had adopted the viewpoint of the water works executive in devising their classifications and in preparing their manuals. If the needs of the executive are provided for, any possible requirements of a state public service commission can be easily met. I do feel that the reverse of this is not necessarily true. The handling of depreciation will illustrate what I have just said.

Depreciation, which is defined as the loss in value of so-called "fixed assets" from the wear and tear of use, is a unit problem and not one to be approached from the standpoint of total fixed assets. A composite rate of depreciation cannot, except by chance, be an accurate measure of the total annual charge for depreciation unless the depreciation has first been computed on the basis of unit assets. A composite rate, accurate for one year, will be inaccurate for later years if the composition of the fixed assets has changed. Even if an accurate composite rate could be estimated, its application would produce a single figure as a charge to total operation—valuable perhaps from the standpoint of adequacy or inadequacy of rates and useful as a device to enable some check to be made upon the total of depreciation expense of a fiscal period; but quite valueless from the standpoint of an executive who wishes to know, and needs to know accurately, the costs of various activities. To leave out the cost of fixed assets used in the various activities may not only violate sound accounting principles but may also affect greatly the amounts charged as costs.

The use of a group composite rate of depreciation, as advocated in some of the later state manuals, represents a step in the right direction since this would permit depreciation to be recorded as one of the costs of an activity. But it falls short of adequate treatment from an angle not previously mentioned. The proper accounting for retirements of unit fixed assets involves knowing not only the cost of the asset, but also that part of the cost which already has been charged to operation, in order to register upon net worth the effect of such retirement. This can only be known when depreciation is computed by units and when the reserve for depreciation is handled as a control account with detail to support the balance in the account in the same manner that a list of unit asset costs supports the asset control account balance.

Another matter, which generally receives such inadequate treatment that neither internal comparisons nor external comparisons as to accomplishments may be made with any degree of satisfaction, comes from the failure to apportion property taxes. Municipal water utilities in many states do not even recognize these taxes or their equivalent. Taxes are costs of an activity in much the same sense as depreciation. They must not be left out of the expense accounts if accurate costs of an activity are to be accumulated. Apparently taxes are not assessed against municipal utilities in most states on the assumption that to assess taxes and adjust rates to cover them is just like taking money from one pocket and putting it in another pocket. The fallacy of this reasoning lies in believing that the two pockets are in the same pair of pants. The taxpayer and the water consumer are not necessarily the same individuals, nor are their interests affected to the same degree when taxes are not assessed. From an accounting standpoint the objection lies in the fact that the failure to include taxes as a cost is heavily understating expenses in an industry where the charge for the services rendered is supposed to be based on the cost of rendering the service and not upon the ability to pay. Such treatment of costs renders almost useless any attempt to regard an operating statement as an accurate portrayal of costs and an accurate stewardship of accounting on the part of the water works executive. Some states apparently understand this since they make provision for entering "short" estimated taxes, but they do not correct the inequity and inaccuracy by providing that all utilities be assessed for taxes on the same basis as other manufacturing enterprises.

The stock reason for failure to assess taxes is that the taxes not assessed are alleged to be exactly offset by giving free water to city institutions and for public fire protection. There may be some ground for this attitude in some locations and in some fiscal periods, but there is a continuing accounting objection to this treatment of revenues. It lies in the serious understatement of revenues which vitiates both the actual operating statement and any attempted internal or external comparisons between statements. The same states which provide for entering taxes "short" also provide for entering "short" estimated revenues from the city. Again this treatment merely recognizes the error but does not correct it. No one, despite the value of financial planning, would advocate the use of a budget profit and loss statement in place of an actual operating statement as an expression of the actual results of current operation. To do this, however, would be simply carrying the same idea many steps further. I wonder how many of the actual deficiencies in water works records may be traced to the philosophy that is behind the exclusion of these important revenues and expenses. I realize that these matters are in general out of the hands of water works executives, but it does seem to me that a direct and stated viewpoint of the water works executives might in time lead to the correction of such obvious errors.

The use of the cash basis of reporting revenues and expenses rather than the accrual basis is another problem that had to be considered. The problem here concerns the accounting period within which the revenues and expenses are reported. One of the distinguished gentlemen here today has rather aptly made this distinction between the two methods of reporting in this way: a revenue is always a revenue and an expense is always an expense. The real difference between the accrual and the cash basis of accounting lies in the date when revenues and expenses are recorded. Cash accounting would report a revenue when cash is received and the accrual basis would cause the revenue to be reported when earned. Cash accounting would record an expenditure when a disbursement is made for it, but the accrual basis would cause the expenditure to be recorded when it is incurred. Besides the accounting objection to the cash method of reporting, there is also the objection that the reports, however accurate from the effect upon cash, may be grossly manipulated by withholding payments.

In summing up the causes of accounting difficulties in the water works field I would say that they come largely from:

1. Lack of a simple, specific, and authoritative handbook of accounting procedure.
2. Failure of state commissions to attack their problem from the standpoint of the needs of management.
3. The philosophy that is behind the intentional elimination of important revenues and expenses.
4. The use of the cash method of reporting revenues and expenses.

Another matter which has contributed to some extent to the lack of completeness in water works records and to the confusion that seems to exist in the use of accounts and procedures is the lack of a dictionary of terms. One of the first steps in the actual preparation of the manual of accounting procedure for water works was the preparation of a glossary of terms. We were fortunate in having available for use in compiling this glossary the work of the National Committee on Municipal Accounting. Many of the terms to be found in the glossary were taken verbatim from the work of the National Committee. Other definitions are based on the language of the National Committee with slight changes when accuracy seemed to demand a different wording. The other definitions are the result of considerable research, discussion, and rewriting based on suggestions received from your own committee. The definitions so far as possible, have been built up on the basis of an exact definition of the term as an abstract thing, which may be used in any field of accounting, with accompanying "notes" when there is a special meaning or application in the field of water works accounting. When any of these terms are used in the manual they will be used in the sense in which they are defined in this glossary.

The next step was the preparation of an outline. The present outline, a copy of which follows this paper, was first prepared in a tentative fashion. As a result of suggestions received from many directions, including your own committee, changes have been made in this outline until it not only suggests complete coverage of the field to me, but will, I think, indicate fairly clearly to anyone else the ground to be covered. The changes made in the outline indicate a different treatment of some matters, and the order of presentation in the manual has been more logically developed. Formerly it had been planned to have subsidiary accounting forms grouped in a section by themselves so that reference could be most readily made.

The present outline has eliminated that section and the forms will now be scattered through the textual material so that they may accompany a discussion of the procedure in which they are used. Ready reference to these forms will be obtained through the use of a list of the forms giving the page on which they appear. This, I think, will add materially to the clarity of the discussions. For the same reason the formal parts of the accounting records will appear in the chapters which have to do with their extensive use. Reference to these forms will be made easy in the same manner as for subsidiary accounting forms.

Perhaps the greatest change from the earlier outline lies in the order in which the material will be presented. There will still be an introductory chapter to state briefly the purpose of the manual, some basic considerations in building good records, and certain accounting fundamentals. This chapter is now to be followed by two other chapters, one of which will explain briefly certain general aspects of an accounting system, how the entire system is built upon a control, and how this control functions. The other chapter will explain how to select the records to be maintained when starting an enterprise, and how to open the books when the enterprise is being started from the ground up and also when it starts by taking over an enterprise which already had been conducting a business.

The chapters which follow the ones just described will deal with the different phases of the accounting and office procedures necessary for the correlation of the accounting information for all activities so that it may be centrally controlled. In one sense no one of these phases is any more important than any other. Some of them take more of the total accounting effort expended as they are mechanically more involved, and some of them are encountered earlier in a period of operation. Taking all of these matters into consideration, the arrangement as indicated in the present outline seems the one that is best from the standpoint of the actual use of the manual. Accounting for consumption and certain related activities takes more of the accounting effort and is more difficult than many of the other phases due to the relatively large number of transactions. Accordingly, this activity will be treated first and followed by a treatment of the procedures for cash since most of the cash will come from the customers and the two procedures are inextricably bound up with the billing, etc., preceding the receipt of cash. Just as revenues are treated before receipts, the treatment of expenses will precede the treatment for the distribution of expense. After discussing the

accounting for revenues and expenses, the manual will present the procedures dealing with fixed assets and fixed equities. These will be followed by the treatment of other balance sheet groups. Finally will come the treatment of problems encountered at the end of the accounting period.

From the introductory chapter to the final page we are attempting to provide a useful guide to bookkeepers and accountants by providing accounting answers to all questions with an accounting significance. The manual will show how accounting information may be accumulated. If there are several ways of accomplishing the same results, no one of which seems to possess marked superiority over another, several of them will be shown. Illustrative journal entries will accompany discussions of the procedures to show how the accumulated information may be recorded and how it reaches the general control of all accounting activities—the general ledger. The manual will also show how information which has been accumulated for a fiscal period may be transferred to the accounting reports and the books made ready to accumulate information as to operation in succeeding periods uncolored by the information of past periods.

The preparation of the preliminary draft of the manual has progressed to a stage where some work has been done on all chapters. Not all of this material however, is in the same stage of preparation. While some authorities advocate the writing and rewriting of an outline in detail until the text can be written at once in its final form, this has not seemed advisable in the case of this manual due to the extent of the ground covered and the time consumed in the writing. Accordingly, a fairly detailed outline has been improvised and the textual material is being written and rewritten. Each chapter is being treated so far as possible as an integral unit. The first writing covers the scope of the chapter and the ideas to be incorporated; the second writing clothes the ideas of the first with the proper language and illustrates them; the third writing removes possible inconsistencies between various parts of the manual and at the same time changes are made to add to the clarity of expression and illustration. The material is in such a stage that I hope it will soon be possible to distribute it, in chapters, to the various committees.

No one should think that the manual, or any part of it, is in anything but a tentative stage until it is published. Criticism and suggestions will be very welcome at any time and you may be sure they will receive careful consideration. No one should assume that the preparation of this manual is in any sense a personal venture. It is

the direct responsibility of the associations sponsoring it and it will be published in the names of these associations. My part is simply to facilitate its completion and the completed work will bear the imprint of many minds. I am very glad that I have had a part in furthering this project which is expected to be a real contribution to accounting progress in the water works field. If the coöperation in the past is any criterion for the future I am sure that the manual will be what we hope for it and will be a complete justification of the time and effort expended upon it by the two associations and their membership.

OUTLINE OF WATER WORKS ACCOUNTING MANUAL

HOW ARE PUBLIC WATER SUPPLIES RELATED TO THE INCIDENCE OF GASTRO-ENTERITIS?*

Public health history records a number of outbreaks of gastro-enteritis, preceding epidemics of typhoid fever, where their water-borne nature was indicated both by the epidemiological evidence and the observed bacterial pollution of the water delivered to the public. In recent years several outbreaks of gastro-enteritis have occurred, which from certain aspects appeared to be water borne, but where bacterial pollution of the water supply was not indicated by the conventional methods of examination. Such outbreaks may not have been water borne, but are frequently assumed so because the water supply was apparently the only vector common to all the patients.

On the other hand, the current methods of bacteriological examination of water may not disclose the presence of the true causative agent. It is not clear that clinicians are in agreement as to the entity of so called gastro-enteritis; nor is it clear that the organisms discussed by certain workers are definitely correlated with enteritis causation.

It may be that the commonly accepted methods of bacteriological examination of water do not meet the needs of the situation. It should be remembered that the efficiency rating of modern water purification through the medium of bacteriological examination is based upon the historical correlation of the presence of coli-aerogenes group organisms with typhoid incidence; that as the recorded density of such organisms in public water supplies was reduced, the amount of typhoid traceable to water borne infection was also reduced; and, it has been concluded that, if the density of the coli-aerogenes type organisms is *definitely demonstrated* to be within the United States Treasury Standard limits, the safety of the water supply is reasonably certain.

* A panel discussion held on June 8, 1937, during the Buffalo convention. The discussion was held under the auspices of the Water Purification Division. The chairman was Carl J. Lauter, Chief Chemist of Filtration Plants, Washington, D. C.

Have the methods of measurement been fully applied? Is there definite evidence of water borne enteritis where the conventional methods of examination have been fully applied and a satisfactory record shown by those methods? If so, what demonstrated methods of examination can be added to the routine which will, beyond any reasonable doubt, demonstrate that water purification technic and results protect the water user?†

C. R. Cox.[1] Water-borne typhoid fever is usually preceded by outbreaks of gastro-enteritis and the incidence of both diseases may be correlated with the bacterial pollution of the water supply involved. The improvement of the quality of water delivered to the public, however, has gradually reduced the incidence of typhoid fever and gastro-enteritis associated with polluted water. The preponderance of typical outbreaks of gastro-enteritis and typhoid fever of bacterial origin in the past also obscured the occurrence of gastro-enteritis apparently of a different character, but which now appears to constitute a much larger proportion of the total number of outbreaks. It should be emphasized that water-borne gastro-enteritis of definite bacterial origin continues to occur.

It is evident that water works and public health officials are confronted with the problem of determining more clearly whether the current outbreaks of obscure character are, in fact, water-borne, or whether they are transmitted by infected food, or by contact, as would be the case with so called intestinal influenza. Irrespective of this epidemiological problem it seems apparent that public water

† Editors Note: The above is quoted from the explanation which was included with the invitations issued to participants in this discussion. The discussions which follow are from the stenographic notes made at the meeting, edited in some cases by the authors. In a few instances space requirements have necessitated the omission of some material which was divergent from the main topic.

Following the presentation of the discussion at the convention a committee was formed with the initial purpose of stimulating the study of water-borne gastro-enteritis and to collect available information as to the result of these studies. A symposium on the subject is planned for the 1938 convention of the Association. The committee has issued a statement in which it has endeavored to summarize the problem and suggest the general course which the investigation should follow. This statement, together with the personnel of the committee is printed in this JOURNAL at the close of this discussion.

[1] Chief, Bureau of Water Supply, Division of Sanitation, State Department of Health, Albany, N. Y. Secretary, Water Purification Division, A. W. W. A.

supplies are implicated in many cases, even though evidence indicates apparently effective treatment, or the absence of known bacterial pollution, as measured by present bacteriological standards of water quality.

The New York State Department of Health in its study of water-borne gastro-enteritis has given careful consideration to various factors. It has appeared, for instance, that certain outbreaks might be correlated with the decomposition of algae known to be very prevalent in the reservoirs serving as sources of supply under study. In other cases prolific growths of crenothrix in spring basins, dug wells, etc., had led to the presence of appreciable quantities of decomposing organic matter. On other occasions the organic content of the water was known to be high and its decomposition was indicated by objectionable odors, etc. These studies have also indicated that many supplies under investigation in connection with gastro-enteritis were practically free from bacteria associated with sewage pollution, that is the 37° agar count was low and organisms of the coli-aerogenes group were absent from all portions of the samples examined, but it was also known that such samples contained anaerobes and other bacteria of possible significance.

None of these studies, however, has led to definite results because it was realized that the decomposition of algae, the destruction of crenothrix, the decay of organic matter, and the presence of miscellaneous bacteria also obtained with other public water supplies without any incidence of gastro-enteritis. It has been impossible, therefore, through these preliminary studies to draw any definite conclusion that these obscure outbreaks of gastro-enteritis were due to the presence in water supplies of toxic substances incidental to previous bacterial action, or to bacterial pollution of a nature not disclosed by conventional laboratory procedures. A problem of such paramount importance, however, should be subject to correlated study, including animal experimentations, by epidemiologists, bacteriologists and sanitary engineers, to disclose the pathogenicity of organisms found present in the supply during the *period of incidence* of the gastro-enteritis.

That in general represents a summary of the problem as we see it. Obviously it does not contribute anything to our knowledge. We thought it might be well to illustrate this situation by giving a more detailed account of a typical occurrence of two weeks ago in a small village near Albany, N. Y., where a characteristic outbreak

has occurred. Mr. Gilcreas of the laboratory of the New York State Department of Health will briefly tell you about this.

WELLINGTON F. GILCREAS.[2] The particular outbreak referred to by Mr. Cox is of interest because the evidence points rather conclusively to its being water-borne. The village is small with a population about 1000. A house-to-house canvass by an epidemiologist who interviewed about 680 of the 1000 population revealed that of the people interviewed about 125 did not use the village water supply and not one of those were ill; that the illness among those using the village water supply was very high, in the neighborhood of 25 to 100; that it was the usual type of gastro-enteritis; and the usual symptoms. The evidence indicated it to be bacteriological and not a toxic infection. The period of incubation was quite long, anywhere from 24 to 72 hours before symptoms developed. The duration of the illness was anywhere from 48 hours up to a week, with varying severity.

To me, the most interesting part of the investigation is the fact that the laboratory examinations failed to show any bacteria that might be considered the cause of the trouble. The water is chlorinated and filtered through not too efficient rapid sand filters. The conventional laboratory examination indicated that the raw water contained coli-aerogenes group organisms but the chlorination was effective. The operating records of the plant also indicated no failure in chlorination during the period of the epidemic. Of course, we have no assurance it did not fail and simply was not noticed by the operator; but his records indicated the maintenance of a continuous residual of chlorine.

In the laboratory, we examined the samples for everything we could think of, including the conventional or routine procedure. Some points developed although I do not know what significance to attach to them. We found the total count of the chlorinated water was not high, possibly 50. The lactose broth test showed gas formation of possibly 20 to 25 per cent but when parallel tubes were used, the gas formation was higher, 90 to 100 per cent in the inner tube. Most of the cultures which we isolated and tried to study proved to be gram positive and spore forming organisms. There was one other significant fact. We ran a 20° count on gelatine. The 20° count

[2] Associate Sanitary Chemist, Division of Laboratories and Research, State Department of Health, Albany, N. Y.

indicated about 150 organisms per cubic centimeter, but because of the presence of liquefiers not affected by chlorination, and because they appeared in all of the chlorinated tap samples which we examined, we cannot say whether they had any significance.

No evidence concerning the origin or cause of the epidemic was obtained from the examination of fecal specimens.

It is difficult to draw any conclusions from the epidemic. I am inclined to think that perhaps our conventional type of bacteriological examination of water does not tell the whole story. The mere absence of B. coli may not mean that the water is satisfactory for consumption and it may not mean that these epidemics may not result. I am still of the idea that in the cases of many of these obscure intestinal outbursts which we encounter so frequently in the state, perhaps if we knew the entire history and all the details we would find that there had been an otherwise unnoticed or unknown lapse in treatment, or a treatment which was inadequate at the particular time. Perhaps in this particular case, if we had a complete record, we would find that the chlorine demand of the water may have gone up for a short time and there may have been a period when chlorination was ineffective. The evidence against that latter point of view is that the water is stored for a considerable time before it is chlorinated. The village has an impounding reservoir with a capacity of 17,000,000 gallons and after chlorination the water is stored in a protected but open basin where it has approximately three days' storage, so that one would almost assume failure of chlorination had been ironed out.

What I am interested in getting are some suggestions as to how we can alter our laboratory examinations, and what things we might look for if we have any more of these epidemics—and unfortunately I expect we will have more this summer—in order that our laboratory studies might be more useful and more significant.

Question. I would like to ask what chlorine residual was carried in the finished water.

Mr. Gilcreas. The residual was from 0.05 to 0.10 parts per million, but with a very long period of contact, nearly three days' contact.

Question. Was the raw water subject to sewage pollution?

Mr. Gilcreas. The raw water is from a mountain source and is not subject to any municipal sewage or trade waste pollution. Any pollution which gets into it is incidental due to picnickers, campers, or from farmland with straying animals. As far as we know, no

cesspools discharge into it. The watershed is uninhabited, although the raw water did contain coli-aerogenes group organisms. In addition to the bacteriological work, I might add we made a chemical analysis. We also made a microscopic examination thinking that perhaps the cause might be gross organisms. No algae growth was observed, although the amorphous count was 4,500 standard units. The oxygen consumed value was approximately five parts per million, but a sample for chemical analysis which had been collected about a month or six weeks before the epidemic showed an oxygen consumed value of three parts, so the increase was not significant. The chlorine demand was rather high. At the time of the epidemic, it was 0.32 p.p.m., but what the chlorine demand might have been prior to the epidemic, I do not know because in our previous chemical examination which was made six weeks previous, we did not make a determination of chlorine demand. However, it appears to rule out the argument that excessive amounts of organic matter might be the cause.

Question. Is there anything significant in the age of the person attacked.

Mr. Gilcreas. The percentage distribution among the various age groups was not particularly significant. Actually if you studied the figure, the heavier incidence was among the older groups, people over fifty, but I think that is in part accounted for by the fact that perhaps there are more people of that age in the village; and in a way it is a "bedroom" town. Many of the younger people go to Albany to work during the day and perhaps don't consume as much of the public water supply as the older people who remain there all day.

Question. Was there any chance for pollution of the reservoir from the outside?

Mr. Gilcreas. It is a concrete basin, with a wall around it; fenced and carefully protected, not covered, but protected from malicious or wilful pollution, either by animals or human beings.

JACK J. HINMAN, JR.[3] The responsibility of the individual who is called to pass judgment upon the safety of a public water supply is a serious one. It is not lightly to be assumed without thorough study and consideration.

In the first place the health and even the lives of the population

[3] Associate Professor of Sanitation, University of Iowa, Iowa City, Iowa.

consuming the water are involved. The consumers must be safeguarded, but they must not be alarmed without cause, else they be driven to the use of other and more dangerous water supplies, such as those belonging to private individuals, who frequently give little thought to the protection of the water of their own springs and wells. Such unsupervised private supplies are often much more dangerous than the public supply, even when health officials are unwilling to approve the latter. But naturally, if there is to be any error in passing judgment upon a public water supply, it must be on the side of safety.

However there is no such thing as absolute safety, either in the matter of water supply or in any safeguard which man has erected thus far. Man may approach the goal of absolute safety, but he has not attained it. His common plan is to introduce what is designated a large factor of safety into his plans—or as it often has been called, a large factor of ignorance. But large factors of safety increase the cost of development and of operation. Expense may be a determining factor for a community urgently in need of a water supply. In such a case communities are obliged to make a choice between available sources and between available procedures designed to give them the necessary protection against the possibility of consuming an unsafe water supply. There are abundant examples in which an unwise choice was made.

The exact point at which the safeguards of a particular water supply begin to become inadequate may be a matter of dispute in many instances. Most of the trouble which has been encountered has come about through failure to recognize existing hazards. Sometimes the failure to recognize these hazards has been due to ignorance of generally known sanitary facts on the part of the designers; sometimes the trouble has been due to slow and insidious changes in a water supply or its distribution system escaping notice until the harm was done. Sometimes the changes have been sudden and radical. Sometimes, unfortunately, deficiencies in the general state of knowledge with regard to the spread of water-borne diseases have existed and even the best informed men of the day have been unaware of the existing hazards and of the means of nullifying them.

As everybody here knows, our present system of water supply protection is aimed at the prevention of certain intestinal diseases, of which typhoid fever is the type. In the minds of many people typhoid fever is the only water-borne disease. During the war

the writer had numerous disputes with medical officers who argued that since the soldiers were protected against typhoid fever by the prophylactic measures taken on entry into the service, chlorination of water in France was unnecessary and undesirable. To be sure this did not represent the best informed medical thought even then. The amebic dysentery epidemic in Chicago has received such publicity that today it is probable that most people understand that there are other diseases than typhoid fever which may have a water-borne origin.

It is also well recognized that typhoid fever is not exclusively water-borne. The causative agents are bacteria which escape with the urine and feces from the bodies of cases and carriers. The organisms must in some way enter the body of a susceptible person. The mouth is the usual portal and water, milk, other foods, and the fingers are the common vehicle by which the transfer is made. It is recognized that all fecal matter does not carry the typhoid organisms and that fecal contamination of water supplies may exist without the immediate development of typhoid fever in the consumers of a polluted supply. But the possibility exists, for numerous persons may contribute to the pollution and some of these may be cases of the disease or may be intermittently or continuously excreting carriers of the organisms of typhoid fever.

For our purpose at the moment it is sufficient to point out that the attack upon typhoid fever and intestinal diseases in the conventional manner has yielded excellent results. Even as early as the 1850's, before a knowledge of the reduction of danger by bacterial removal was available, it was observed that filters improved the safety of the London water supply passed through them. Even the introduction of the older types of filters, imperfect though they were, produced great reduction in the prevalence of intestinal disorders though our estimate of the amount of improvement due to the filters alone is somewhat inferential, rather than susceptible of exact appraisal. Chlorination and improved water purification practice with improved laboratory supervision have produced even greater reduction in water-borne disease. These are matters of common knowledge.

Water-borne disease has become so rare in the larger cities that there is even a danger that responsible officials may not realize the need of keeping continually on the alert to prevent its return. There is a danger that the need of sufficient material and equipment, and of sufficiently trained personnel may not be recognized

in every locality. A desire for reduction in current expenses has impelled some city officials to adopt such expedients as the reduction of the chlorination of the city water to an ineffective point in an effort to save a few cents a day in chlorine costs. Yet Wolman and Gorman showed only a few years ago that there is urgent need to maintain the defenses against water-borne disease and that it has been only the continuous attack against fecal contamination of waters which has kept typhoid fever from again assuming menacing proportions as a water-borne disease. Even at the present time epidemics of typhoid fever—now usually due to milk or some other agency other than the public water supply—are reported. And occasionally we learn of an epidemic in which the water supply has been incriminated.

But as time has gone on, occasional outbreaks of intestinal disorders have occurred which have resembled water-borne disease in their manner of spread, their explosive character, their general distribution and in other ways. Sometimes these outbreaks have occurred at times when the protection of the public water supply was known to have been defective, or to have broken down for some reason. Sometimes they have occurred when an impure water has entered a system normally containing only a safe water, as through a cross-connection. But sometimes these outbreaks have occurred in communities served with a good water supply, closely supervised by frequent laboratory control tests, and although certain indications point to the water supply as the source of the trouble, the available results of water examinations and all other data seem to give the supply as clean a bill of health as could be desired. The question which then comes up is whether our system of water examination is as complete, as accurate and as sensitive as it should be to give us adequate protection; whether there are responsible conditions which are so transitory as to escape detection; or, whether there is some agency other than water which is actually the cause of the intestinal disease reported.

As we see it now, it is surprising that no one until comparatively recently emphasized the dangers involved in back-siphonage from toilet fixtures and other water outlets in homes and buildings. The danger from this situation is surprisingly universal and surprisingly little has been done to prevent the possibility of sucking polluting matters into the house piping system. Defective plumbing fixtures exist everywhere. Experienced and careful inspection is

necessary to ferret out the defects of each plumbing installation. And any person who attaches a bit of hose to a faucet, letting it hang down into a vessel containing a liquid, creates a new hazard when he opens the faucet. The pollution so introduced can contaminate the whole piping system of the premises and may persist for an astonishingly long time, even when the water runs in the normal direction through the pipes thereafter. The pollution thus introduced may conceivably get back into the mains from which the house supply is derived and may produce a local area of danger. An isolated group of cases of intestinal diseases may result.

Who is responsible? The back siphonage possibility definitely points to the desirability of maintaining adequate elevated storage tanks at points in the community area where low pressures are apt to be experienced at times, so that the pressure will not fall to zero in case the pumps stop momentarily or longer. It points to the undesirability of allowing the dropping of the water pressure for any reason whatsoever. It points to the need for mains large enough for all demands, so that exceptional demands in one locality may not lead to abnormally low pressures in the system at some other point. But most of all it points to the need for some effective means of controlling the character of the plumbing fixtures and of supervising their installation. This is most difficult. And then, what about the fellow with his bit of hose?

It is manifestly unjust to hold a water department responsible for the activities of the fellow with the hose which he attaches to his faucet and may later detach and carry away after the harm has been done. It is manifestly impossible to know the condition of the water within the pipes in all of the houses. It is difficult enough to eliminate the danger of cross-connections to unsafe private supplies—but in the present state of affairs it seems almost hopeless to prevent dangers from back-siphonage. One of the first outbreaks of intestinal disease of the sort we are to discuss this afternoon, so far as the writer's knowledge is concerned, was probably of the back-siphonage type. At that time we suspected that some workman using a force pump had driven pollution back into the water system while at work on domestic plumbing. But it seems now that back-siphonage was more probable. This particular outbreak was localized and not widely distributed, but there was no common cause detectable in the epidemiological study.

However there have been a number of other intestinal outbreaks

of unknown etiology in which the distribution of cases was more general. The series of outbreaks reported in several Ohio River cities by Veldee in 1931 constitute a case in point. Whether that series of epidemics came from irritant chemical materials derived from wastes or from the degradation of organic matters, has not, so far as the writer knows, ever been established. The results of the examination of the public water supplies apparently concerned were generally good. The wide distribution and the timing of the outbreaks seemed to incriminate the water in the absence of any other known causative agency. Possibly there may have been another factor. The recent work of Wells on atmospheric pollution has given us different ideas about air carriage of infection than we used to have. But air carriage does not seem a likely explanation for these epidemics.

In other localities various other speculations have been made to account for observed gastro-intestinal disorders which the epidemiologists could not otherwise account for, except as water-borne, even though the water examination results have been good. Among these speculations as to toxic agents are toxic substances from blue-green algae, toxic action, probably sometimes allergic, due to pollens falling into surface waters, dust contamination of open reservoirs of treated waters and so on.

Epidemiology is not an exact science. It is more of an art enlisting the services of many sciences in its application. An epidemiologist must possess many of the properties of a good detective. He must understand the etiology of the diseases he has to study. He must have a notion about how they are likely to be spread and he must be willing to do the slow and difficult work of eliminating one possibility after another so that he may make his final conclusions very certain. He must be strictly honest. He must not make snap judgments. He must not become a protagonist of one idea of the spread of the disease he is studying and the antagonist of all others. He will have to work with information much of which is incorrect, either through faulty recollection or through design. But the more honestly and the more thoroughly he studies his problem, the more certain is he of arriving at the actual cause of the trouble and the more valuable will be his suggestions as to its elimination as a cause of future difficulty.

In the study of water-borne disease it should be pointed out that a carelessly conducted epidemiological inquiry can do a great deal

of harm. Great care should be taken not to point the finger of blame until it is certain that it is deserved. Otherwise the public may turn in fear from a reasonably adequate and safe water supply to the grave danger of a multitude of uncontrolled and almost certainly polluted private sources. A statement that evidences of of the presence of pollution have been detected will probably be translated into the statement that the organisms of typhoid fever and other intestinal diseases have been isolated. The calling of any recovered organisms typhoid-like is usually interpreted by the lay reader as meaning that the actual typhoid organisms were present. And as a matter of fact, the bacteria isolated may be very different.

Statements have recently been made that the existing bacteriological procedures upon which opinions regarding the safety of water supplies have commonly been based, are inadequate to detect the presence of significant pollution and danger. Few water laboratory men would care to state that the analytical methods at present in use are perfect and that they are adequate under all possible conditions. We do not know that they are. Yet they have served us reasonably well and it does not seem wise to discredit them indiscriminately until something better can be developed. Most of the criticisms of the existing methods pertain to unusual situations and circumstances. It is pretty well agreed that under the usual circumstances the present methods will detect a significant contamination and permit it to be detected with as little delay as is now possible. Speed in water tests is essential if corrections in treatment are to be made soon enough to be useful in avoiding unsatisfactory quality in the water pumped into the system. The criticisms of the analytical methods by the water supply industry itself have been chiefly that the results of the tests are so slow in coming to hand. Speed and extreme sensitivity under unusual circumstances do not go well together in test procedures. Yet if the results of a test are delayed too long, the results are of no value as aids in the correction of treatment defects and thus may be said to have only an historical value.

At the present time there seem to be three lines of inquiry which may be pursued with advantage:

1. An attempt to develop specific tests for the pathogenic bacteria which may be present in water. The extreme difficulty in finding these organisms is well recognized as is the fact that too

great reported success in detecting them in water samples is apt to be regarded as evidence of defective technique. Procedures for various pathogenic bacteria have been developed from time to time in the past, but have not been generally satisfactory.

2. An attempt to detect the presence of the organisms of streptococcus type as a routine procedure. The procedures have long been known, but have not been used.

3. An attempt to learn more about the slow fermenters of lactose. The work of Parr on the lactose-degraded aerogenes type organisms seems to the writer to be very significant. In cool waters there seems to be a possibility that certain of the aerogenes type organisms may lose their lactose-fermenting power, while retaining their dextrose-fermenting power and certain other characteristics which make it especially difficult for any except a highly experienced person to distinguish them from paratyphoid and certain other pathogenic bacteria by cultural tests. On this account, the slow lactose fermenters seem apt to be encountered most frequently where old fecal contaminations in cold waters are concerned. Such conditions would be found when polluted ground waters are to be dealt with and also in the spring when treated waters derived from cold surface sources are being examined.

The observation of Parr that feces may be found free at times from detectable colon-aerogenes organisms has been confirmed by other workers. But the condition is unusual and where the feces of more than one individual or the feces of one individual at more than one time are concerned in the pollution of a water, it is not likely that any error in the consideration of the colon-aerogenes concentration will be involved.

ALBERT E. BERRY.[4] The persistent decline in typhoid fever and other long recognized diseases which may be associated with water supplies has signalized a noteworthy advance in public health. Unfortunately this accomplishment has not meant the freedom from intestinal infections for which we might hope. Such infections and resulting illness are quite familiar to public health administrators. These experiences have been encountered in the province of Ontario to some considerable extent, and to a degree which might be said, at

[4] Director, Sanitary Engineering Division, Department of Health, Province of Ontario, Toronto, Ont.

times, to be distressing. The conditions under which these outbreaks have occurred have tended to make complete investigations very difficult. The result has been that in most cases no definite conclusions concerning the cause have been possible.

The part which water supplies may play in these outbreaks of ill-defined origin is at least uncertain. One fact, however, seems obvious, in that this problem is a perplexing one, and one which should be studied further at every opportunity.

Gastro-enteritis outbreaks of epidemic proportions have occurred in the Province of Ontario for years. From these and other experiences certain observations have been made. They have taken place over widespread areas, at different seasons of the year, and with various factors present. They have not been confined to centers where uncontrolled water supplies were in use, nor where food supplies were so uncertain as to attract suspicion.

The causes of these outbreaks are open to conjecture, but in so far as water supplies may be concerned some questions naturally arise. One of the first of these is to what extent is this illness due to bacterial infections, and to what extent to chemical or other irritants. Observations would point to the possibility of irritants in the intestinal tract playing a prominent part. An example of this is found in a small public water supply in Ontario, which carries much fine quartz silt. Normally this water is filtered and chlorinated and no ill effects are experienced. By-passing of the filter, even when the samples are bacteriologically satisfactory, is followed by marked gastro-enteritis among the consumers.

The part which algae may play in this illness does not appear to be well established, but from the observations made on the effects produced in animals there is a question as to possible effects on humans. Some years ago in a small lake in Ontario the decomposition of an abundant growth of anabaena caused the death of some 20 animals which drank the water. Similar instances have been reported elsewhere.

In Ontario these enteric outbreaks have been noticed particularly in summer colonies in the lakeland regions. They occur at different times of the year, but are not found every year in the same places. Most of these waters are surface supplies in which algae are fairly abundant. Moreover, they are encountered both where the water is chlorinated and raw. The efficiency of chlorination at those times is open to question, but hardly offers a reasonable explanation.

Milk and food supplies similarly have not been proven as the cause. Some years ago after chlorination was adopted the reports were to the effect that an improvement had been made. Whether this was merely seasonal is a question.

This whole problem is one which would appear to justify some carefully organized investigation. Little of a definite nature is known. The situation in Ontario has been responsible for planning an intensive investigation this summer in those areas where it has, in the past, been most prevalent. The laboratories of the Department of Health have adequate supplies of anti-sera for members of the salmonella and bacterial dysentery groups of organisms. A very wide collection of stock cultures has been maintained, and a complete study of biochemical and serological characteristics of all strains isolated can be made. It is hoped that this year's work may produce results of value in arriving at the probable causes of these outbreaks.

DR. NEWELL R. ZIEGLER.[5] The possibility of water-borne outbreaks of gastro-enteritis, dysentery, and typhoid fever arising or continuing in the absence of positive tests for members of the colon-aerogenes group has been considered in our laboratory from the standpoint of bacterial variation. Earlier investigators have found it possible to completely inhibit gas formation from certain sugars by *E. coli* and other organisms. This has been confirmed and extended to other sugars, including lactose, in the course of investigations at the University of Missouri. The loss of gas formation is a gradual process and is obviously related to the presence of an unfavorable environment such as might be provided when colon bacilli are suspended in water. Although one would expect typical members of the coli-aerogenes group to exceed other organisms in a polluted water, this is not always true. For instance, if there has been no fresh pollution introduced into a surface supply during a long period of drought, as occurred at Springfield, Missouri, in July 1936, the number of typical gas-forming members of the coli-aerogenes group may be very small even in the raw water; yet organisms very closely related to if not variants of the colon bacilli are found in considerable numbers. Such late or non-lactose-fermenting organisms may readily escape inadequate chlorination and in

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turn escape detection in infected waters by our Standard Methods of Water Analysis. Such organisms and others of the intestinal group, including *Bacillus pyocyaneus*, can be recognized readily by the use of simple bacteriological procedures in addition to the usually satisfactory minimum methods outlined as standard *E. coli* which have either no power or a decreased ability to ferment lactose have been isolated from cases of disease of the urinary bladder and of the intestinal tract by Dudgeon and others in England, and have been reported by a number of investigators in the United States in greatly increased numbers in cases of diarrhea. Gram-negative, late-lactose-fermenting organisms were also isolated from the Springfield, Missouri, water supply and from patients there as reported earlier. Such organisms isolated from the filtered and chlorinated water were agglutinated in dilutions of the patient's serum as great as 1:1000.

Hornung (Münchner Med. Wchnschr. **83**: 1264 (1936)) reported further on the so-called "Wasserkrankheit." An earlier outbreak had been followed by typhoid fever. Examination of the water at that time showed the presence of *E. coli* and paracoli. Some time later intestinal illness developed among the people using the same water. Bacteriological examination of the water at this time did not show any *E. coli,* but paracoli were found. Serum of three of five people who had been infected agglutinated a paracolon bacillus isolated from the water at a titre of 1:80 but failed to agglutinate other strains of paracolon bacilli. Another outbreak of acute diarrhea was studied by Hornung. In this instance the total bacterial count of the water was 400 organisms per cubic centimeter. No colon bacilli were found, but paracolon bacilli were present. Similar organisms were isolated from the stools of infected persons. This outbreak of diarrhea was followed by at least 30 cases of typhoid with 5 deaths. Hornung concluded that the presence of paracolon bacilli is at least a danger signal which, if not considered seriously, may permit a typhoid outbreak to occur, particularly if gastro-enteritis has been produced.

The outbreak of gastro-enteritis at Springfield, Mo., to which earlier reference has been made, affected about 20,000 to 35,000 of the 65,000 inhabitants during a period of about a month. Following this, typhoid fever occurred until a total of 197 cases with 24 deaths had been reported. Dysentery has been held accountable for an additional 21 deaths in this outbreak. The cases of typhoid, which were well scattered throughout the city, were more numerous near

the filtration plant. Although colon bacilli were isolated from the city supply by some investigators during the epidemic, late-lactose-fermenting types were present earlier and were isolated when typical members of the coli-aerogenes group were no longer found.

By permission of the Chief State Sanitary Engineer, the residual chlorine in the completed water leaving the filtration plant had been lowered. Early in February 1937, the residual chlorine at taps in the business district of Springfield, Mo., was 0.35 ppm., and on February 23, it was 0.30 ppm. At that time, two of 5 tubes inoculated with 10 cubic centimeters each gave late-lactose fermentation between 48 and 72 hours. During the following month the residual chlorine dropped further and Gram-negative, non-spore-forming, late-lactose-fermenting bacilli were found with increasing frequency. During the same time observations in clinics and reports from physicians showed an increasing number of cases of acute diarrhea, particularly in children, but also in adults using city water. At the request of the city Health Department, the chlorine residual was raised sufficiently to eliminate the late-lactose-fermenting organisms. Following this cases of diarrhea ceased.

The amount of chlorine which may be necessary to destroy *E. coli* or disease-producing intestinal organisms will undoubtedly vary with different purification systems, depending upon the content of organic matter in the water, contact time, and other factors. The work of Heathman and co-workers (Public Health Rep., **51**: 1367 (1936)) at the Minnesota state laboratory indicates that freshly isolated *E. coli* may survive a chloramine content of 0.23 ppm. for 1.19 hours at room temperature or 1.7 hours at a low temperature. Similarly, *B. typhosus* may even survive after all the *E. coli* are killed. One can state that our ordinary ideas of the effectiveness of small chlorine residuals may need revision. Certainly it is unsafe to apply chloramine residuals at the same levels as may be satisfactory for chlorine, but this is still often done. Possibly chlorination should be done at a higher level and followed by dechlorination.

It appears from our own work and that of others that when only a few coli-aerogenes group organisms are present in a sample of water, negative results may be obtained if the sample is shipped some distance before inoculation. This source of error is evidently not generally appreciated and may be a serious hazard to the health of a community when there is no close coördination between plant operation and the prevalence of intestinal disease in a community.

At Columbia, Missouri, where an outbreak of dysentery occurred in October 1936, deep wells of both the city and university were found polluted. Since emergency chlorination was discontinued, members of the coli-aerogenes group have been found in a number of tap samples which were inoculated immediately but were not found in samples which were in transit a number of hours before inoculation. Some samples from each of the sources of supply studied contained no typical members of the coli-aerogenes group, but late-lactose-fermenting types (paracoli) and organisms culturally identical with members of the salmonella or paratyphoid group were isolated. During this time intestinal infections, including Flexner dysentery and paracoli infections, have continued to occur sporadically. In one instance a paracolon bacillus was present in pure culture in the blood and in almost pure culture in the stool of a patient who had suddenly collapsed as a result of this infection.

The following procedures might be considered for the prevention and control of outbreaks of gastro-enteritis and related intestinal disorders:

1. Incubation of presumptive tests for at least 72 hours and preferably 96 hours before discarding with a negative report, particularly if samples are shipped to a central laboratory.

2. Because of the impractical nature of such a long incubation period, the elimination of all Gram-negative bacilli which will grow on Endo agar might be more useful, particularly when disease is prevalent in a community. The amount of chlorine required to accomplish this is likely not much greater than that required to kill *E. coli.* This method has been used effectively during one outbreak of water-borne disease.

3. The use of dextrose broth instead of lactose for presumptive tests. This method would demonstrate paracolon bacilli and members of the salmonella group which may be present in the absence of colon bacilli.

4. Proper consideration of an increasing total count in a supply should hardly need mentioning, but it is a procedure that is ignored in some laboratories merely because it is no longer a definite requirement. The reëstablishment of some limiting value for the total bacterial count of potable waters would appear worthy. This would eliminate waters with high counts of Gram-negative organisms.

5. Chlorination might be carried out at higher levels followed by dechlorination.

6. More general use of larger volumes of water than 50 ml. for the inoculation of presumptive tests may be desirable.

7. Inoculation of samples immediately after collection. The use of a mobile water laboratory may be useful in this connection.

8. Less satisfaction with the minimum standards of potability as determined by the U. S. Treasury Standard and a more rigid application of fundamental bacteriological principles for the correlation of the types of organisms found in the water supply with the prevalence of intestinal disease in a community.

DR. LELAND W. PARR.[6] As a medical bacteriologist whose field is intestinal bacteriology, the problems of water workers as they relate to waterborne disease deeply concern me. I am also much interested in outbreaks of gastro-enteritis and dysentery in which the etiology is obscure. From this point of view, may I offer a few remarks?

To get the best possible bacteriological appreciation of a water quality, it is necessary to adhere more strictly to standard methods rather than less closely. Caldwell and I showed a few years ago that very few state laboratories were even pretending to examine water properly. Total counts had been dropped, icing discontinued, and much delay allowed to elapse between sampling and analysis. Very little attention has been given to the need for neutralizing the action of chlorine or other purification chemical at the time a water is sampled when time elapses between collection and analysis. Doubtless filter plant laboratories are more careful. We hope so. We demonstrated the feasibility of direct inoculation in the field, not only into broths, but into plates and we hoped that our results on the use of the direct method, including plating, might encourage others to make use of these procedures. We may speak frankly, it is our opinion that most public health laboratories are not interested in water work; they would rather chase a virus or point the identifying finger at a pallid spirochete or a Gravis type of diphtheria bacillus. This point is particularly important when there is an outbreak of gastro-enteritis in a community. The Health Department then sends in an unpracticed pinch-hitter and as often as not all that he gets is a third called strike.

Mention has been made that in these recent gastro-intestinal out-

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breaks there is less subsequent typhoid than there used to be. To my mind this does not prove that the gastro-intestinal outbreak was not incited by polluted water. We must remember that typhoid infected material in most environments is very much less common than it used to be. It is less apt now than formerly to be present in pollution. Indeed I think it may be questioned if the typhoid which used to follow in the vanguard of gastro-enteritis caused by polluted water entirely came from that water. In the past there were many instances of typhoid bacilli in men's bodies existing in what I like to call the incubation carrier state. In most such cases, no typhoid occurred. But in the wake of gastro-enteritis the sub-threshold dose of typhoid bacilli proved sufficient to bring about a clinical case of the disease. The number of such incubation carriers in any community depends upon the exposure facilities. In recent years cases of typhoid have decreased. Sewage has been safeguarded and water purified. There should be a negligible amount of typhoid following gastro-enteritis.

Much more difficult to explain are gastro-intestinal outbreaks where the coli-aerogenes index of the water is above reproach. But even here a bacteriologist may rush in where a water works operator may fear to tread. We may note:

(a) The shocking but not killing effect of chlorine. In reading over records of the year 1930, we are struck by the tremendous demand made by water for chlorine. I note, for instance, that at Warren, Ohio, in one case "7 lb. per mg." failed to show a trace of residual chlorine. In such water, saturated with organic matter, it is not impossible that bacteria might survive chemical treatment. In such a case, they would be semi-dormant. They would not show gas in 24 hours and probably not in 48. But introduced into the body, they might multiply and quickly gain again their normal metabolic activity. We offer also the possibility that bacteria vary markedly in their individual resistances to environmental factors. It is not impossible that the bacteria in 1930 which survived in the great Kanawha and Ohio rivers were particularly inured to a chemical environment and able to withstand more chlorine than would be the case for coli-aerogenes group organisms ordinarily encountered.

(b) It is furthermore entirely possible that the gastro-intestinal upsets of 1930–1931 and others more recent were chemically incited. Veldee's report to that effect seems most logical. There are several

possibilities as to the origin of the chemical incitant. The dead fish in the Ohio impress me less when I realize that in the tide-water areas on the coast the invasion of salt water also killed fish.

If the outbreaks were chemically incited what can we say about the wide range of abnormal bacteria recovered from the sick? I should like to offer the suggestion, for it is as yet nothing more, that medical bacteriologists have been woefully slow to look upon bacteria isolated from the sick as of any category other than etiological. I should like to suggest that we apply the principles of ecology to the human body. Change the body by illness and one changes the so-called normal flora. In bacteria which multiply so rapidly such transformations may take place in a few hours. Why may we not at times look upon bacteria as symptoms of disease rather than always as the cause? Let the body be grossly upset by a chemical or by a virus and what is more logical than that a new flora would appear. Viruses are particularly known to be accompanied by a rather characteristic type of bacteria, although I am not suggesting that the evidence favors a virus etiology.

(c) While on the point of chemical irritants, let me make one more suggestion. In the food poisoning field, our knowledge has been greatly expanded in recent years. Not only do animal strains of salmonella cause food poisoning but also some staphylococci and to our surprise some streptococci. The conditions which make a pathogenic *Staph. aureus* produce enterotoxin as well as hemolysin, leukocidin, necrotizing toxin and the like are not yet known. Bacterial toxins are extremely potent and some are quite resistant to heat, etc. We may have in drought years a greatly increased enterotoxogenic activity on the part of bacteria as yet unsuspected.

(d) I should like to call your attention also to the anaerobes of the bowel as possibly implicated. You may recall that many years ago an oubtbreak in Montclair, N. J., was held to be due to the *Cl. welchii*. That should be borne in mind. But when I say anaerobes, I am not referring to the classical anaerobes, the sporebearing welch bacillus, but to the group called bacteroides. Not one bacteriologist in one hundred has cultivated these organisms and yet they are the most numerous bacteria of the normal bowel. What do the bacteroides do in the bowel? Is the activity always benign? This group should be studied both from its possibilities as an indicator of fecal pollution and also to see if any of the group are capable of inciting disease.

(e) In view of the numerous references to the presence of algae in waters suspected after purification of giving rise to gastro-enteritis work with these former is clearly indicated.

Lastly, I should like to sketch over some of my own work in the hope it may be suggestive.

I have been interested in the succession of forms which occurs in fresh feces and in feces long stored. We have found that occasionally one encounters a normal stool from which coliform organisms cannot be isolated. Fecal pollution can exist in a water and its coli index may be perfect. This is not common and ordinarily should not occur in community excreta. The antibiotic action indicated is, however, worthy of note.

We have found that there are some stools in which only coli is present and others in which only citrate utilizers occur. Generally there is a mixture. Coliform bacteria cannot be divided into fecal and non-fecal. When feces is stored, particularly at low temperatures, different forms succeed each other until at last we have slow lactose fermenting coliform organisms. We are indebted to Hinman for the suggestion that this finding may be important in the consideration of ground waters whose temperatures approximate those of our storage experience.

We are at present working on a more ultimate storage product of feces which may have a bearing on our panel discussion. When feces are long enough stored, the coliform bacteria disappear, even the lactose degraded ones. But before this, and after, the feces contain large numbers of gram negative non-sporebearing bacteria which grow aerobically and which, to my surprise, resemble culturally a variety of typhoid bacteria. Some are like paratyphoids, some are like typhoid, some are like dysentery bacilli, some are proteus, or like it, and some resemble but are not identical with alcaligenes fecalis. To date, we have studied thirty-five strains of these organisms culturally and to some extent serologically. Of peculiar interest are the cross reactions which these organisms give with known pathogenic members of the colon-typhoid group. A certain relationship is indicated which is worthy of further study. These organisms do not ferment lactose. They are found in long-stored feces. They would be missed in water analysis. When they occur *E. coli* is gone. They may be implicated in drouth gastro-enteritis.

FRANK E. HALE.[7] I wish to refer to some of the early developments as to coli-aerogenes group tests. When the Standard Methods were revised in 1912, Dr. D. D. Jackson was Chairman of the Bacteriological Committee and I collaborated with him in that revision. I wish to call attention to some of the statements in that volume with which some of you may not be familiar. On page 81 was presented a then new classification of the B. coli group. This classification has held a favorite place in my mind because it identifies various distinct members of the group, of which there are over twenty varieties described. The present classification divides the group into two main divisions, *coli* and *aerogenes*, and these groups are too general for specific individual identification of the various members existing under these headings. The classification in 1912 grew out of work by Dr. Benjamin White and Dr. Avery of the Hoagland Laboratories, the research institution of the Long Island Hospital, Brooklyn, N. Y. Organisms were recovered from various pus sores and other conditions and sent to Mt. Prospect Laboratory for identification. Vaccines were made from the cultures and these vaccines frequently cured the condition. Whether the particular coli form was originally responsible for the condition is difficult to say, but there was strong indication that it had something to do with it. On pages 82 to 86 are given descriptions of the numerous varieties and the sources of the cultures. I wish to read from a few of these.

B. Communior, variety A_1. "Isolated . . . by Dr. Avery . . . from two cases of chronic cystitis and from an abscess associated with streptococci in a chronic case of cellulitis. . . ."

variety B. ". . . from Dr. Avery . . . and isolated from urine from a case of cystitis."

B. Communis, variety A. "Isolated by Avery from a case of cystitis."

variety B. "Isolated by Avery . . . from a case of urinary cystitis . . ."

B. Aerogenes, variety A_1. ". . . isolated by Dr. White . . . from a urinary fistula . . ."

variety A_2. "Isolated by Avery from a case

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of chronic urethritis and from a case of cellulitis associated with B. pyocyaneus and Streptococcus pyogenes."

variety B_2. "Two strains isolated by Melia from feces of persons suffering from diarrhoea."

B. Acidi-Lactici, variety B. ". . . nine strains isolated by media from feces of persons suffering from diarrhoea."

Undoubtedly, there are members of the coli-aerogenes group which when out of their environment are associated with disease conditions. Cultures of the above varieties were kept for many years. They were transplanted and rejuvenated every month until finally the labor became too great and they died out. However, the original characteristics and fermentations could be obtained after proper rejuvenation.

I am entirely in sympathy with the search for specific causes of diarrhoea or other disease that may be caused through water supply, and for means of identification of such germs from water supply. We introduced in the 1912 Standard Methods the Hesse Method for isolation of *B. typhosus.* By that method we were able to isolate the germ from water in 1 ml. In one instance a fly cage was brought to us. It was filled with flies caught in an ice cream parlor. In an adjoining room was a boy sick with typhoid fever and the mother was attending the boy and serving the ice cream. I didn't dare let the flies loose, so sprayed them with water from a wash bottle and from this we were able to isolate the typhoid germ by means of bile media and the Hesse Method, despite the numerous other contaminating germs necessarily present. I was probably responsible for the following comment in the 1912 Standards, page 102, last paragraph (statement made over twenty-five years ago):

"The isolation of the cholera germ has long been a practical matter, the isolation of B. sporogenes and other spore forming bacteria may be made by means of liver broth, and B. typhi has been isolated by the method described by at least five different observers. It is certainly desired that more work along these lines be carried on in the experimental laboratories and that methods be perfected for the isolation from water of paratyphoid bacilli and the various types of bacteria producing diarrhoea."

I sincerely hope that the present agitation will not lead to an increase in the residual chlorine maintained in treatment of water supply. The present taste troubles arise in many instances from the

maintenance of too high a residual. No residual chlorine is required to produce the necessary sterilization. Only a fraction of the absorption value is generally needed. This has been shown in our own work in New York City and corroborated by research work on both water and sewage in New Jersey (Dr. Rudolfs) and by recent work in India (see abstract page 749, J. A. W. W. A., Vol. 29, May 1937). The only reason for residual chlorine is to be sure some is present so as to catch variations in the absorptive value of the water from time to time. It is my opinion that the action of chlorine is first obtained in the bodies of the germs and that this explains a large part of the absorption of chlorine. Only those germs that form spores are likely to survive the usual chlorine dosage. There are some germs that do not form spores that have increased resistance to adverse conditions such as the germ of tuberculosis. In this case it is somewhat protected by a fatty layer in the outer portion of the germ. Also the aerogenes group may survive under adverse conditions but are readily killed by the usual chlorination. In New York City practice we maintain residual chlorine between .05 and .10 ppm. and the coli-aerogenes group is generally absent in 100 cc. quantities daily tested at the large chlorination plants.

With regard to relying upon the coli test for the safety of water supply, it seems to me that experience has generally shown this to be reliable. In New York City we have never used the lactose broth with confirmation in routine tests, though numerous comparative tests have been made over long periods of time. Reliance is placed, and has been for years, upon the presumptive test with brilliant green bile. Recently one of our bacteriologists was sent to the flooded sections of Kentucky and was responsible during the month of February for the quality of the water supply of the various camps, individual well supplies, and at Paducah. He carried with him full equipment for making the brilliant green bile test without confirmation. No tests were made for total bacteria counts. The water supply was put into service upon the results of his work and frequently within 24 hours he was able to indicate whether water supply was safe. There was a tendency to overdose individual wells with chlorine, but he was able to demonstrate the low chlorine absorption in many instances and thus prevent overdosing. Such overdosing would have led to people drinking from possibly contaminated wells that had been overlooked or not treated. So far as I am aware there has been no epidemic of diarrhoea or typhoid in

that territory and there certainly was every opportunity for such with the conditions that existed.

With regard to prevalence of diarrhoea, it is not as great a problem as it was many years ago. In a paper prepared by me for the International Health Board, and published in the Municipal Engineers Journal (New York City) in 1921, 2nd Quarter issue, pages 1–36, entitled "The Development of the Sanitary Safeguards of the New York City Water Supply and its Relation to Typhoid Fever and other Diseases," there are included several charts showing incidence of typhoid fever and diarrhoea in New York City and its various boroughs over a period of 20 years, 1900–1919. The two diseases dropped proportionally by about 90 percent, indicating similar sources of the diseases and similar effect of sanitary measures that had been taken. Undoubtedly improvement in water supply was not the only factor, but pasteurization of milk and general sanitary improvement accounted for most of it. In New York City today, considerable attention is being paid, as elsewhere, to possible cross-connections within buildings, but only few instances of such cause have been noted. Foodstuffs, particularly pastries, seem to have been more generally incriminated.

Regarding attenuation or changes of characteristics of various germs, we made experiments several years ago ("Studies of Inhibition, Attenuation & Rejuvenation of B. Coli," Melia & Hale, Jour. Infect. Dis. **7**: 587 (1910)) in which *E. coli* was kept in quart bottles at ice-box temperature, room temperature, and 37°C. incubator temperature. For the first week gas formation occurred within 24 hours. By the end of a week, two days were required, and at the end of the experiment, about nine weeks, three days were required. In other words, attenuation took place as to power to produce gas. If, however, cultures are rejuvenated, original powers return. These changes are widely noted with various diseases. There are mild cases of typhoid, measles, diphtheria, influenza, etc., but that does not change the identity of the germ producing the disease. I am not a strong believer in the transmutation of germs, though the evolution of germs probably slowly takes place as in animal life.

George D. Norcom.[8] The occurrence of outbreaks of intestinal disease in two or three American cities, where conventional methods of bacteriological examination of the water showed it to be free from

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coliform organisms, has again brought this subject to the front for discussion. Because of the lack of sufficient authentic information on these outbreaks and because of a lack of such information on any similar outbreak, discussion must be largely confined to personal opinions and interpretations. When an outbreak of this kind occurs, the cause may lie in any of the following possibilities:

1. A failure of purification equipment or personnel.
2. The presence of a chemical toxin or irritant.
3. The presence of living organisms capable of causing gastroenteritis which are unaccompanied by coliform organisms, as defined by Standard Methods.

Examples of the first cause are so common that investigation may ultimately show that it is the only one of the three which exists in the case of normal water supplies, other than in theory. The conditions which might bring about the second cause appear to be associated with such gross pollution as might occur in times of extreme drought or emergency when the water supply is so repugnant to the consumer that it would not be tolerated by the consumer under ordinary circumstances. The third possibility is hard to visualize in the case of properly purified water supply and it raises the question of how frequently and thoroughly were Standard Methods applied in order to prove the absence of coliform organisms *at all times*.

Public health authorities and the water works profession as a whole can be justly proud of the record which has been established throughout this country for the production and maintenance of safe water supply. It is hardly necessary to mention the decline in typhoid fever case and death rates since the perfection of modern water purification facilities.

Methods of bacteriological examination of water supplies, as outlined in the various editions of Standard Methods of Water Analysis, appear to have served their purpose faithfully and well if we are to judge from the records of properly equipped and properly operated water supply systems. It is true that there have been occasions when improperly purified water has gained access to the mains in spite of precautions, but, as mentioned above, the reason for this has generally been found to have been avoidable.

The investigation of the resistance of various strains of typhoid and coli-aerogenes to chlorine and chloramine, carried out in the course of an investigation by Heathman, Pierce and Kabler of typhoid fever in Minneapolis, (Public Health Reports, **51:** 1367

(1936)) presents conclusions which would lead us to reconsider chlorination practice and the significance of coliform organisms. The findings of this investigation are especially important to those plants where chlorination is the only method of purification. I think most of us are willing to admit that in dealing with fresh pollution there is necessity for the employment of relatively high residual chlorine for relatively long contact periods. We know also that waters of high organic content are difficult to sterilize with chlorine. However, experience has taught us that water polluted by sewage or fecal matter is certain to contain large numbers of coliform organisms, and if our tests after purification demonstrate that we have removed or killed practically all of these organisms we assume that we have also killed any pathogenic organisms which may originally have been present. This assumption seems logical and justifiable when we consider the difficulty of attempting to demonstrate the presence or absence of the various pathogens and the amount of time consumed in such research, more particularly in view of the fact that adherence to this assumption has carried us so far in the production of water which has not caused disease.

In considering the work of Heathman, Pierce and Kabler, the writer has noted the fact that the experiments on the resistance of certain organisms to chlorine and chloramine were laboratory experiments and that the initial numbers of organisms employed in the killing tests ranged from 80 to 850 per ml. in the preliminary experiments, and from 150 to 350 per ml. in the later experiments. This amounts to a concentration of 8,000 to 85,000 per 100 ml. As a result of his exhaustive study on limiting standards of bacterial quality, Streeter (Jour. A. W. W. A., **27:** 1110 (1935)) has recently suggested an average Coli-aerogenes group limit of 50 per 100 ml. and a maximum of 400 per 100 ml. for waters requiring simple chlorination. While these limits are conservative, they may well be accepted as within the order of magnitude accepted in common practice. Obviously the concentrations of organisms used by Heathman, Pierce & Kabler were entirely outside the range of simple chlorine treatment and, in fact, outside Streeter's limits for waters requiring filtration and chlorination. The amount of organic material present with such high concentrations of bacteria might immediately absorb much of the chlorine to form organic combinations which in turn might release free chlorine when treated with an acid solution of ortho-tolidine.

In the case of the epidemic of intestinal disease which occurred at Springfield, Mo. the article appearing in the American Journal of Public Health, March, 1937, failed to give a complete and adequate picture of the source of raw water, methods of purification employed, and the type of control available. Unless the bacterial content of the various raw waters was known and could be compared to similar results on the treated waters by means of adequate bacteriological examinations, one could not expect to determine definitely whether or not the water purification process was efficient. The demonstration of organisms resembling paratyphoid and dysentery in the treated water should have been accompanied by similar demonstrations of the presence of these organisms in the raw water. It would appear that there were circumstances accompanying this epidemic whereby the water in the distribution system could easily have become contaminated through sanitary defects in plumbing (Report Upon Inspections of Plumbing Installations and Water Supply Cross Connections, Springfield, Mo.—January 1937) and it appears that a number of cases of intestinal disease occurred at premises where such sanitary defects were particularly flagrant. Such pollution in the distribution system probably would not have been detected immediately by bacteriological examination of samples as carried out in ordinary water works control for the simple reason that it is impractical to examine regular samples from every faucet in a distribution system. From such reports of this epidemic as have come to the attention of the writer it would appear that the evidence is not such as would justly impugn the standard method of bacteriological water analysis in common use and much additional information would be necessary before any such conclusion could be reached. If such information exists it should be made available to all.

In closing I wish to repeat that much additional evidence will be necessary in order to cast serious doubts on the reliability of Standard Methods of Water Analysis as an indicator of the safety of water supply. Perhaps what is needed is a wider and more serious application of these methods. At any rate, we, as operators, will continue to depend upon Standard Methods and on the long record of safe water supply which has been attained until such time as bacteriologists agree on more complete and better methods. Technical study of the entire problem will have to be left to a committee of experts.

MR. F. H. WARING.[9] I have been asked to talk on recent outbreaks in Ohio—one at Coshocton and one at Mansfield. I shall read my report on the Coshocton outbreak.

On February 20th, 1936 and again on February 23rd representatives of the State Department of Health visited Coshocton to investigate the existing public water supply and to determine if possible the cause of an outbreak of so-called gastro-enteritis. Samples of the public water supply were procured for bacterial and chemical analyses on both dates from many representative points upon the entire distributing system. Inquiry was also directed toward the status of the construction of the P.W.A. project for the improvement of the existing water works. Following the investigations, recommendations were given relative to the expansion of the scope of the P.W.A. project to include a modern water purification and softening plant.

For a period of three weeks to a month preceding February 14th, low temperature conditions prevailed over the entire state with many days of subzero temperature. On February 14th, a rise in temperature was state-wide which resulted in a general thaw of ice and snow with consequent increase in the flow of the rivers and streams. Some breaking up of ice occurred causing local ice jams at many points and the flooding of limited areas behind such jams. On February 18th and 19th there was reported from Coshocton the prevalence of intestinal illness which reached epidemic proportions on those days. The outbreak affected some 600 school children and some 900 adults uniformly distributed over the city. It will be observed that 1,500 cases in the estimated present population of 12,000 constitutes a considerable outbreak and, therefore, resulted in general alarm within the city as to the cause of the disturbance and the possible consequences. Epidemiological investigations by the medical representative of the State Department of Health failed to show that milk or other food carriers were the cause of the outbreak; it appeared that if the outbreak were not to be attributed to a form of influenza, then the only medium common to the general public that could be the cause of the outbreak would be the public water supply. Local medical opinion was found to be divided as to whether the outbreak was of the influenza type or an intestinal illness such as would be caused by contamination of milk or water.

[9] Chief Engineer, State Department of Health, Columbus, Ohio.

The epidemiological conclusions are, therefore, not definite as to the exact nature or cause of the outbreak.

The public water supply of Coshocton is obtained from a dug well, ten small diameter drilled wells and a 24-inch drilled well, all grouped in a regular pattern on about one acre of ground located near the point of junction of the Walhonding and Tuscarawas Rivers, forming the beginning of the Muskingum River, about 800 feet north of the Sycamore Street bridge and generally at the northwest corner of the city. All wells are pumped by direct suction, the suction piping consisting of a common 20-inch header. The main suction line extends from the well field southeast 1000 feet and passes beneath the Tuscarawas channel. Normally, the well field is subject to the flooding of either the Tuscarawas or Walhonding rivers. Generally, all wells, including the dug well, extend to the surface of the ground where the well casings are capped with a blank flange. A gasket prevents the entrance of flood water. The dug well is equipped with a cast iron manhole fixture closed with a blank flange and gasket.

The P.W.A. improvements under construction comprise a new pump station housing steam-operated electric generators and new electric operated high service pumps, each 700 gpm. The project also includes three new drilled wells on the east bank of the Tuscarawas River adjacent to the pump station, each of which wells will be equipped with motor driven deep well pumps discharging into a new suction well for the high service pumps. The original plan also contemplated the construction of a water purification and softening plant which plant, however, was deferred in the development of the P.W.A. project for construction at a later date not to exceed ten years. These P.W.A. improvements are being financed out of mortage revenue bonds. If the water purification and softening plant are to be constructed, it will be necessary to issue general obligation voted bonds.

On about Friday, February 14th, a short general thaw in the Walhonding Valley above Coshocton caused the breaking up of ice in the channel and caused a jam near the junction of the two streams at Coshocton. Water levels raised so as to flood the well field with water and ice. In 1935 during flood stages and during which the well field was covered, turbid water reached the distribution system in Coshocton. Similar occasions have been noted previously. At the time of the investigations of February 20th and 23rd, water

in both the Walhonding River and the Tuscarawas River was clear; there were observed large cakes of clear ice that had been lifted by the rise in the Walhonding River and deposited over the well field. It is possible, in view of past history, that the flood waters seeped into the well structures.

The main suction line enters the pump station at a level some 12 feet below the ground surface and in a pit which houses the lower construction of an existing Holly low and high service pump, steam driven. The suction line extends along the floor to a connection with the present pump. Two 12-inch valved but open tees with the inverts located on the pump pit floor are provided in this suction line. Drainage of the pit stands in the open tees and partially drains to a sump at one corner of the station. The suction line at the wall of the station is fitted for the injection of chlorine from a machine located on the floor above the pit. This pit in 1935 was filled with flood water.

A Wallace and Tiernan MSP type chlorinator with a capacity of 10 lbs. per 24-hours was purchased and installed in 1926. Recent investigation of this chlorinator machine has indicated the injector equipment to be seriously out of repair and in need of replacement. At the normal operating capacity of the Holly pump, 2 mgd., the chlorinator has been regularly set since 1935 to feed at a rate of 4.8 lbs. in 24-hours, or .28 ppm. This feed normally gives a residual at the pump station of .08 ppm.

Inquiry disclosed that the Holly pump, the only high service unit, has been in constant operation to maintain the usual operating pressure of 126 lbs. on the system during the extreme cold weather. The only exception to this is for two or three minutes at long intervals when the pump is shut down for greasing. During these times the chlorine is permitted to run to waste. The chlorinator also has been in constant operation with no record of a shutdown. The present chlorine cylinder is of the 150 lb. type and at the time of this investigation showed a gross weight of 220 lbs. or a net weight of 97 lbs. of chlorine, slightly more than ten days demand having been removed according to the present rate of chlorination. An extra cylinder of chlorine has been on hand for at least thirty days.

Upon investigation of the distribution system, there were found six industrial plants having private water supplies, and five of these plants were found to have direct cross-connections with the public water supply, protected only by check and gate valves. Since,

however, there have been no broken mains or fires in the past fifteen days, no occasion has been afforded for the introduction of the private supplies into the public water supply system.

Two high level distributing reservoirs with a total capacity of 3.5 million gallons float on the distributing system. Since these reservoirs are located some distance from the main pump station and practically on the opposite side of the city, it will be observed that there is little chance for rapid displacement of the water content of these reservoirs and the distributing pipes. Therefore, the samples of water collected on February 20th would likely be representative of some water that had been pumped into the distributing system many days previous, in spite of the fact that the citizens were generally letting water run to waste to prevent freezing of services.

Analyses at the time of these investigations of February 20th and 23rd indicate that residual chlorine existed at sampling points in the center of the city but that no residuals existed in the outlying sampling points.

The sampling points were distributed to include the main pump station, the central part of the city, and the local high school and outlying sections, many of which were so-called dead ends. Eight bacteriological samples were collected on February 20th and nine on February 23rd; all of these samples were reported as negative for the presence of B. coli and all but one were negative in the presumptive test.

Owing to the nature of the development and the location of the public water supply wells at Coshocton, it is possible that flood waters could enter the public water supply system. Chlorination as practiced normally would effect the sterilization of the water except where the water was turbid or where a toxic substance was present or where unusual pollution was present in the flood water. The investigations did not disclose that any of these conditions existed. The fact that samples collected three days following the epidemic were without exception of satisfactory quality, in part precludes the likelihood that the water was of bad enough quality to have been responsible for the outbreak. It is improbable that any of the cross-connections mentioned were the cause of the outbreak.

This concludes the report of the investigation of the Coshocton outbreak.

About a year ago in Mansfield, we had a terrific typhoid outbreak—140 cases of typhoid is a considerable epidemic in a city of

120,000 people. Again we were unable to prove conclusively that the city water supply was the cause. In our own minds we felt that the water supply was responsible. The epidemiological evidence pointed to a contamination of the high service water supply system. The geographical distribution chart showed that all of the 140 cases were on the high service system. That cast the finger of suspicion. When all the facts were brought together three or four months later, we were able to reconstruct what had occurred. The hard winter and spring of 1936 resulted in about 600 breaks in the mains of that city. In the high service system, the level of the reservoir was lowered. Simultaneously with that there was a heavy rain, and surcharging of sewers,—manholes were observed to be overflowing and running over the gutter. Is it any stretch of the imagination to figure out how sewage got into the high service system at Mansfield? Be that as it may, in our dealings with the City of Mansfield we considered that there was no use in causing suspicion. You may agree that possibly the city water supply was responsible for the outbreak, but one's first duty as a Public Health and Water Works official is to find the trouble in the system. There is where we concentrated. As soon as we were able to get the evidence, we then had the problem on our hands, as is true in the case of every such outbreak, of restoring the public confidence in the water supply. The quicker you can do that, the better off you are. I, for one, know it is the wrong thing, to cast a finger of suspicion on a water system unless you have very, very definite proof. That takes time to get. When you do have the evidence, you still have the problem before you of getting confidence restored in the public water works system.

I now refer to the Salem epidemic of 1920–21. There we knew by the simplest bacteriological test within twenty-four hours of the time we arrived in the city that the water was completely polluted. We disconnected the one line which we found to carry the pollution. We disconnected the source of it. It takes, as you know, two weeks for all the cases to develop after the time when we stopped the infection. During that interval, the pressure was great on us, but we stuck to our guns. We had to declare martial law. We had to go around and disinfect every dug well and cistern, and we did it by force. We had to restore the confidence of the people in the public water supply.

Be careful, extremely careful how you scare the citizens of a city or a village about the public water supply. You cannot go upon

mere circumstantial evidence or a doubt or suspicion, because you have a greater responsibility. If you overlook that greater responsibility, you will find you are driving the citizens to these unknown sources of water, unknown in quality such as the dug well and the old abandoned cistern. That is infinitely worse than that water supply that might be under suspicion due to an outbreak of so-called gastro-enteritis.

DR. JOHN F. NORTON.[10] I wish to emphasize three points. The first is that epidemiologists have distinctly failed to be of any help in connection with these intestinal outbreaks. They do not occur always, of course, in communities that have a common water supply. We have plenty in western Michigan in summer resorts where each house has its own well. Second, it is up to the medical bacteriologist to find the cause—and it is about time for me to sit down because the medical bacteriologists also have failed. Dysentery and diarrhea have been studied for many, many years. We have not arrived at any definite conclusion. Whether dysentery organisms, paratyphoid, paracolon bacilli, proteus or streptococci are involved or whether we are dealing with some chemical factor, or even with some action of two or more bacteria operating in the intestine at the same time, is not known. That is the point of view from which we have to start in this study, and I believe Dr. Berry's plan in Ontario is the way to do it. You have to be on the spot when the outbreak starts. It is the only way to do it. You cannot get anywhere with specimens that come into the laboratory even twenty-four hours after the person has been taken ill. The third point is that I have a very strong feeling that there is nothing sacred about Standard Methods of Water Analysis or about the standards that are in common use for designating whether a water supply is safe or not. I have also a strong feeling that our standard methods are not always adequate, and I think that the discussion this afternoon has brought this out. The bacteriologists must develop some methods which are much more conclusive, which will yield us results of much more value than we are getting at the present time in dealing with these gastro-enteritis outbreaks.

ABEL WOLMAN.[11] I came to listen. About ten minutes ago, Mr. Lauter asked whether I would close the discussion. I am glad to do so.

[10] Head, Bacteriological Department, The Upjohn Co., Kalamazoo, Mich.
[11] Chief Engineer, State Department of Health, Baltimore, Md.

Before doing so, however, I must attempt to isolate the facts, in so far as they appear, from the fancies. I am reminded of the time I got off the train in Chicago and met Arthur Gorman and Joel Connolly about the time of the peak of the dysentery epidemic. These two gentlemen said to me: "The Doctors and the Bacteriologists are debating what the organism is; what we are worried over is what we ought to do about it."

In general summary, that is perhaps the most outstanding fact in my own mind with reference to the material that has been presented here today. One fact appears: there have been a number of actual occurrences of peculiar types of water-borne epidemics. I put that down as a fact only on the basis that the epidemiological evidence, circumstantial in nature, seems to show that the water supply has had something to do with the case. I repeat in that connection also that, after all, this is the only kind of evidence we ever had as far as I am aware on most typhoid fever epidemics which we now completely accept as having been caused by water supply. The fact that it is circumstantial, at least from my own standpoint, is enough to worry about. A large number of cases of some enteric disturbances have occurred in a variety of populations, and, in general, sound circumstantial evidence appears to justify the conclusion that the water had something to do with it.

Then we get into another phase which I think is not fancy but which should be commented upon. Two kinds of attitudes arise, defense attitudes if you please, both of which are important to this group,—certainly important to anyone interested in the permanent control of water. The first defense attitude implies that someone is pinning an epidemic on a water supply, as innocent as some people we could mention! The other feeling is that it might have been due to the water supply, but inasmuch as we cannot find any of the current indices of pollution, we ought to forget about it. Either attitude seems to be an unwise one. If we could put ourselves back perhaps twenty-five or even fifty years when, if we review the literature of that time without the bacteriological support we have today, we find, roughly, the same attitudes and the same reasons for proving in a variety of ways that there were some mysterious agents disseminating typhoid fever through the community, which later on was found to be due to water supply.

Those attitudes should give way, at least in summarizing this symposium, to a desire to isolate, if possible, the cause, and more

important than that perhaps—I am speaking unscientifically—to begin to set up the defenses at once without waiting for Doctor Berry's results of this summer or anybody else's. We should set up the defense procedures in our plants where some of these things indicate improvement is needed.

There have been two viewpoints outlined this afternoon. One originates in a staunch defense of methods which, to some, have gotten to be as sacred as the bible. Those who have had anything to do with them know that they rest on a sand foundation. They are an empirical document and like most empirical documents, they ought to give way, if and when we know better, to another set of criteria.

The other group is ready to discard them in their entirety. I want to point out that at the 1935 American Public Health Association Meeting where new techniques of identification for shellfish organisms were being studied, I made the point, and I think it is worth repeating, that some standard techniques have had the tendency, during the last twenty-five years, to become more and more specific and, I believe, less and less protective to the consumer. I want to repeat that: The desire and the search has been for the specific pathogenic organism, not the coliform group, but for a simple, easy identification of the typhoid organism itself.

Theoretically, the best index of an inferior water supply, as far as pathogenicity is concerned, is the man who died. The next one is the clinical case. The third one up the line is the specific typhoid organism. In each of those steps, we become more specific. As the specificity increases, the consumer becomes, gradually, the goat. Our older techniques were not more sensitive; they were cruder; they were catchalls. I find, and I have been over a good part of the United States from time to time, that there is an undue tendency to select that kind of technique or organism which might produce the best showing and which eliminates many of the organisms that have not been proven to be of pathogenic character. By these refinements the margin of safety for the consumer is decreased.

The consumer should come first rather than second. The technique should be subordinate to the purpose of affording maximum protection.

I am interested also in the occasion as related by Mr. Gilcreas, and am astounded by the high chlorine demand of a filtered water in the New York Community. I have been interested perhaps for

fifteen years in the fact that in this country, in contradistinction to foreign ones, the residual chlorine test has daily consecutive application. I always felt, as far back as 1918, that residual chlorine is a most sensitive indicator of any conglomerate change in the quality of the water, particularly of field waters. I hope this suggestion may even lead to current routine determination of chlorine demand on your finished product, not in order to control the chlorine dose, but to give us a rapid, sensitive indicator when something is going wrong.

One of the bacteriologists properly referred to the possibility of extending the collection of samples in the field by inoculation in the field. Doctor McCrady in Canada, at least twenty years ago, instituted that system for the very reasons we are hearing discussed. It is rather interesting that it should be recalled. It is a technique that might be properly used in the cases such as we have reported here today.

When we get these epidemics which appear to be conveyed by water supply, it is not proper for us to discount them—certainly not to conceal them; but to devise techniques for their early identification, and to put up our barriers to prevent their recurrence.

Statement of the A. W. W. A. Water Purification Division Committee for Coordinating Methods of Water Treatment and Laboratory Control (July 12, 1937). Inadequate knowledge of the factors underlying water-borne gastro-enteritis led to the inclusion of a panel discussion of the subject on the program of the Buffalo convention. It was hoped in this way that the present state of our knowledge would be clarified and the Association advised as to desirable future action.

Comments by various sanitary engineers and bacteriologists clearly indicated the absence of definite information on water-borne gastro-enteritis, the complexity of problems involved, and the need of a correlated study by epidemiologists, pathologists, bacteriologists and sanitary engineers before definite conclusions may be drawn. While there was no agreement among the discussors as to the important factors involved, it seems possible to make the following general, summarizing statements:

1. That gastro-enteritis epidemics may be due to the consumption of infected milk, food and water, although there is some evidence to support the possibility that a few outbreaks of gastro-enteritis may be transmitted by "droplet infection," even though there seems

to be no certainty as to the clinical entity known as "intestinal influenza."

2. That care should be exercised in ascertaining, insofar as possible, that a public water supply is the most probable vector of gastro-enteritis before the public is informed; otherwise, confidence in a public water supply system may be destroyed in an unjustified manner.

3. Water-borne gastro-enteritis epidemics may be due to:

a. Bacteria accompanied by organisms of the coli-aerogenes group and miscellaneous bacteria developing on agar plates at 37°C., that is, by bacterial pollution as indicated by present standards as to water quality.

b. Bacteria present for a short period of time during the onset of the epidemic, either due to temporary pollution of an untreated supply or temporary failure of the effectiveness of water purification processes, which bacterial pollution is not disclosed by available records because samples were not collected during the period of incidence of the epidemic or were collected at poorly selected sampling points, or were collected too infrequently.

4. Certain individuals have lately suggested that water-borne gastro-enteritis epidemics may be due to:

a. Bacteria which are not accompanied by organisms of the coli-aerogenes group or by miscellaneous bacteria which develop aerobically on agar, that is, by bacteria not disclosed by standard methods of examination of water.

b. Lactose fermenting bacteria which have lost their fermentative ability due to unfavorable environmental conditions; or which ferment lactose slowly; or which produce acid without accompanying gas formation—which prevents their disclosure by standard methods of water examination.

c. Toxic or irritating substances incidental to previous decomposition of organic matter or previous bacterial action, but not accompanied by bacteria of public health significance, these substances being resistant to the action of water purification processes, which, however, remove accompanying bacteria which might otherwise be held responsible for the outbreak. It is evident that toxic substances cannot be shown to be responsible for gastro-enteritis unless the ab-

sence of bacterial pollution can also be shown, including the absence of resistant anaerobes, and other bacteria not disclosed by standard methods.

In view of the lack of definite knowledge regarding 4a, 4b, and 4c, water supply and public health authorities should instigate detailed and correlated study of the problems to determine once and for all whether any or all these factors may be included as the cause of outbreaks of gastro-enteritis, which may possibly be waterborne, even though there is an apparent absence of bacterial pollution of the water.

A. E. Berry
C. R. Cox
Geo. D. Norcom, *Chairman,*
Coordinating Committee on the Methods of Water Treatment and Laboratory Control, American Water Works Association, Purification Division.

TYPHOID IN THE LARGE CITIES OF THE UNITED STATES IN 1936*

In preparing this annual review, data have been obtained from the same ninety-three cities which have been referred to in similar articles for the years beginning with 1930. A communication was addressed to the health officer of each city asking that he furnish the number of deaths from typhoid, excluding paratyphoid, for the year 1936. Furthermore, the health officer was asked to designate not only the total number of typhoid deaths but also subdivide these as to resident and nonresident. Special comment was solicited on any unusual outbreak of typhoid that occurred during the year. In each instance (except Scranton, where the figures come from the Pennsylvania State Health Department) the data were supplied by the respective health departments.

As the United States Census Bureau is not prepared to furnish an estimate of population for these cities, the health officer was asked to designate the local estimate which he is using in his statistical compilations. A review of these figures as submitted indicates that they do not vary to any great extent from the 1930 census figures, and if there has been a misjudgment in estimating these population figures the error in the rates is not significant. In a few instances (as indicated in the footnote of tables 1 to 8) the health department did not furnish a local estimate and the 1930 census figures were used.

As has already been stated, the deaths from paratyphoid have been excluded. The need of giving particular heed to this question of residence is well illustrated in the case of Columbus, where the health department reported twelve deaths from typhoid and stated that all were among nonresidents. Fifty-seven cases occurred at the Columbus State Hospital for the Insane and there were nine deaths in this group. The health officer reports that this institution is not under

* Reprinted, by permission, from the Journal of the American Medical Association (Vol. 108, pp. 2118–2121, June 19, 1937). Previous reproductions of this annual summary have appeared in the Journal of the American Water Works Association as follows: Vol. 20, p. 257; Vol. 21, p. 963; Vol. 22, p. 1122; Vol. 23, p. 1059; Vol. 24, p. 1066; Vol. 25, p. 1157; Vol. 26, p. 939; Vol. 27, p. 1593; and, Vol. 28, p. 1123.

the jurisdiction of the local health department. There were reported thirty-three deaths in New Orleans and it is stated that twenty-five of these occurred among nonresidents. El Paso reports five out of seven deaths among nonresidents. Houston, with thirteen deaths, has made no separation on the basis of residence.

Six of the large New England cities report no death from typhoid in 1936 (table 1). Bridgeport, Somerville and Springfield report no death for three years in succession. Boston had but one death in 1936 and this is reported as having occurred in a nonresident. The

TABLE 1

Death rates of fourteen cities in New England states from typhoid per hundred thousand of population

	1931–1935	1926–1930	1921–1925	1916–1920	1911–1915	1906–1910	1936	1935	1934
Fall River	0.2*	2.2	2.3	8.5	13.4	13.5	0.9	0.9	0.0
Lynn	0.2	1.5	1.6	3.9	7.2	14.1	1.0	1.0	0.0
Bridgeport	0.3	0.5	2.2	4.8	5.0	10.3	0.0	0.0	0.0
Somerville	0.4	1.3	1.6	2.8	7.9	12.1	0.0	0.0	0.0
Waterbury	0.4	1.2	1.0	8.0	18.8	....	0.0	2.0	0.0
Boston	0.6	1.2	2.2	2.5	9.0	16.0	0.1	0.5	0.9
Worcester	0.6	1.0	2.3	3.5	5.0	11.8	0.0	0.5	0.0
New Haven	0.7	0.6	4.4	6.8	18.2	30.8	1.2	0.0	0.0
Cambridge	0.9	2.1	4.3	2.5	4.0	9.8	0.0	0.0	0.9
Lowell	1.0*	2.6	2.4	5.2	10.2	13.9	1.0	1.0	0.0
Springfield	1.0	0.4	2.0	4.4	17.6	19.9	0.0	0.0	0.0
New Bedford	1.1*	1.5	1.7	6.0	15.0	16.1	1.8	0.0	1.8
Providence	1.1	1.3	1.8	3.8	8.7	21.5	0.8	0.8	1.2
Hartford	1.2	1.3	2.5	6.0	15.0	19.0	0.5	0.6	0.6

* Rate computed from population as of April 1, 1930, as no estimate for July 1, 1933, was made by the Census Bureau.

New England cities as a whole (population 2,630,017) again report a new low record of 0.42, which is but 60 per cent of the 1931–1935 quinquennial average.

The Middle Atlantic states have a group rate which is approximately the same as that for the preceding year (0.56 in 1936, 0.55 in 1935). There were no deaths recorded in Utica and Syracuse for 1936, and in Scranton there have been three consecutive years without a death. The honor roll list for this group of cities is not quite as good as for 1935, there being but three cities with no deaths, compared with seven in the preceding year. Elizabeth, having success-

TABLE 2

Death rates of eighteen cities in middle Atlantic states from typhoid per hundred thousand of population

	1931–1935	1926–1930	1921–1925	1916–1920	1911–1915	1906–1910	1936	1935	1934
Jersey City	0.2	0.9	2.7	4.5	7.2	12.6	0.6	0.0	0.0
Newark	0.3	0.9	2.3	3.3	6.8	14.6	0.2	0.0	0.2
Reading	0.4	1.6	6.0	10.0	31.9	42.0	1.8	0.9	0.0
Rochester	0.4	1.7	2.1	2.9	9.6	12.8	0.6	0.3	0.0
Buffalo	0.6	2.7	3.9	8.1	15.4	22.8	0.3	0.5	0.3
Utica	0.6	1.1	3.9*	....	....	....	0.0	1.0	0.0
Yonkers	0.7	0.5	1.7	4.8	5.0	10.3	4.8	1.4	0.0
New York	0.8	1.3	2.6	3.2	8.0	13.5	0.4	0.5	0.6
Syracuse	0.8	0.8	2.3	7.7	12.3	15.6	0.0	0.5	0.5
Elizabeth	0.9	1.6	2.4	3.3	8.0	16.6	0.8	0.0	0.0
Philadelphia	0.9	1.1	2.2	4.9	11.2	41.7	0.7	0.9	0.9
Pittsburgh	0.9	2.4	3.9	7.7	15.9	65.0	0.7	0.6	1.5
Paterson	0.9	1.0	3.3	4.1	9.1	19.3	0.7	0.0	0.7
Erie	1.0	0.9	2.3	6.9	49.0	46.6	0.8	0.0	1.7
Albany	1.1	1.8	5.6	8.0	18.6	17.4	1.5	0.8	0.8
Trenton	1.1	2.1	8.2	8.6	22.3	28.1	0.8	0.0	0.8
Scranton	1.4	1.8	2.4	3.8	9.3	31.5	0.0†‡	0.0†	0.0
Camden	2.8	4.4	5.9	4.9	4.5	4.0	0.8	2.5	1.7

* Incomplete data.

† Typhoid deaths for Scranton furnished by Pennsylvania Department of Health, Harrisburg.

‡ Rate computed from 1930 census population, as no local estimate was given.

TABLE 3

Death rates of nine cities in South Atlantic states from typhoid per hundred thousand of population

	1931–1935	1926–1930	1921–1925	1916–1920	1911–1915	1906–1910	1936	1935	1934
Baltimore	1.4	3.2	4.0	11.8	23.7	35.1	0.9	1.5	1.3
Wilmington	1.5	3.1	4.7	25.8*	23.2*	33.0	0.9	0.9†	1.9
Jacksonville	1.7	4.4	....	....	....	....	1.3	0.0	1.4
Miami	2.2	3.5	....	....	....	....	3.1	2.8	1.8
Richmond	2.5	1.9	5.7	9.7	15.7	34.0	2.7	2.7	3.8
Washington	2.6	2.8	5.4	9.5	17.2	36.7	1.6	2.6	1.6
Tampa	3.0	3.8	19.1	43.9*	....	....	0.0	6.6	0.0
Norfolk	4.2	2.2	2.8	8.8	21.7	42.1	0.0	5.4†	5.4
Atlanta	7.2	11.1	14.5	14.2	31.4	58.4	3.2	4.6	3.9

* Incomplete data.

† Rate computed from population as of April 1, 1930, as no estimate for July 1, 1933, was made by the Census Bureau.

fully passed through four consecutive years without a death, reports one resident death in 1936. It is stated that the disease was contracted in another state by an Elizabeth resident. The four cities in this group, with a population of more than half a million, all had rates under 1.0, New York for the fifth consecutive year, Philadelphia and Buffalo for the fourth, and Pittsburgh for the second. Yonkers reports seven resident deaths with no comment regarding any special

TABLE 4

Death rates of eighteen cities in East North Central states from typhoid per hundred thousand of population

	1931–1935	1926–1930	1921–1925	1916–1920	1911–1915	1906–1910	1936	1935	1934
Grand Rapids	0.2	1.0	1.9	9.1	25.5	29.7	0.6	0.0	0.0
Milwaukee	0.2	0.8	1.6	6.5	13.6	27.0	0.3	0.0	0.2
Chicago	0.4	0.6	1.4	2.4	8.2	15.8	0.3	0.4	0.6
Detroit	0.6	1.3	4.1	8.1	15.4	22.8	0.5	0.3	1.1
Flint	0.7	1.6	4.6	22.7	18.8	46.9	1.2	0.6	1.2
South Bend	0.7	....	....	....	....	....	0.0	0.9	1.8
Akron	0.8	1.5	2.4	10.6	21.0	27.7*	0.8	0.7	0.4
Dayton	0.8	1.9	3.3	9.3	14.8	22.5	1.8	1.0	1.0
Canton	0.9	1.4	3.3	8.9	....	....	1.0†	0.9	0.9
Peoria	0.9	0.2	3.7	5.7	16.4	15.7*	1.7	0.0	0.0
Cleveland	1.1	1.0	2.0	4.0	10.0	15.7	1.0	0.6	0.8
Youngstown	1.1	1.1	7.2	19.2	29.5	35.1	1.1	0.0	0.6
Indianapolis	1.2	2.7	4.6	10.3	20.5	30.4	0.8	1.3	1.1
Toledo	1.3	3.0	5.8	10.6	31.4	37.5	1.0	1.3	1.3
Cincinnati	1.4	2.5	3.2	3.4	7.8	30.1	1.9	1.3	1.5
Evansville	1.9	6.2	5.0	17.5	32.0	35.0	0.0	4.7	1.9
Columbus	2.0	2.1	3.5	7.1	15.8	40.0	3.7	2.0	2.0
Fort Wayne	2.2	4.2	12.9	7.3	....	....	0.0	0.0	6.7

* Incomplete data.

† Rate computed from 1930 census population, as no local estimate was given.

outbreak. The rate for this city of 4.8 is the highest in the group and is equal to the rate for the same city for the five years 1916 to 1920. This is in striking contrast to the low rate of recent years. Jersey City records two deaths, both in nonresidents, one a resident of Bayonne, the other of Cliffside. Reading, with two resident deaths, reports an outbreak of twenty-one cases (fourteen resident, seven suburban) traced to a privately owned contaminated well used by a manufacturer in a section of the city recently annexed. Of

the thirty-one deaths reported from New York City it is stated that thirty occurred among residents. An outbreak of fifty cases occurred in October 1936, traced to a memorial cake used in a Greek Orthodox Church on September 13.

TABLE 5

Death rates of six cities in East South Central states from typhoid per hundred thousand of population

	1931–1935	1926–1930	1921–1925	1916–1920	1911–1915	1906–1910	1936	1935	1934
Louisville	2.3	3.7	4.9	9.7	19.7	52.7	1.4	1.6	2.5
Birmingham	3.9	8.0	10.8	31.5	41.3	41.7	5.0†	4.0	5.8
Chattanooga	4.7	8.0	18.6	27.2	35.8*	....	0.0	2.4	8.1
Nashville	5.6	18.2	17.8	20.7	40.2	61.2	4.4	7.0	2.6
Knoxville	5.7	10.7	20.8	25.3*	....	....	4.1	5.4	0.9
Memphis	7.9	9.3	18.9	27.7	42.5	35.3	4.7	5.0	8.4

* Incomplete data.

† Rate computed from 1930 census population, as no local estimate was given.

TABLE 6

Death rates of nine cities in West North Central states from typhoid per hundred thousand of population

	1931–1935	1926–1930	1921–1925	1916–1920	1911–1915	1906–1910	1936	1935	1934
St. Paul	0.7	1.4	3.4	3.1	9.2	12.8	0.7	0.3	0.0
Wichita	0.7	1.2	6.3	...	...	....	1.9	0.0	0.0
Minneapolis	0.8	0.8	1.9	5.0	10.6	32.1	0.0	1.2	1.2
Omaha	0.9	1.3	3.3	5.7	14.9	40.7	0.9	0.0	0.9
Duluth	1.0	1.1	1.7	4.4	19.8	45.5	0.0	1.0	1.0
Kansas City, Kan.	1.1	1.7	5.0	9.4	31.1	74.5*	2.3	1.6	1.6
Kansas City, Mo.	1.5	2.8	5.7	10.6	16.2	35.6	0.5	1.0	1.4
St. Louis	1.6	2.1	3.9	6.5	12.1	14.7	0.8	0.7	1.7
Des Moines	2.1	2.4	2.2	6.4	15.9	23.7	2.8	2.1	6.2

* Incomplete data.

The South Atlantic cities recorded a marked reduction in the death rate for the group as a whole (1.55 in 1936, 2.58 in 1935). Tampa and Norfolk report no deaths. These cities had the highest rate in the group for 1935, 6.6 and 5.4 respectively. Jacksonville's excellent record of no death in 1935 was spoiled by the reporting of two resident deaths in 1936. Atlanta, which has long had a high rate among

the cities of this group, has the highest rate again in 1936, although the rate of 3.2 is significantly lower than that of previous years and quinquennial averages. Of four deaths in Miami, three are recorded

TABLE 7

Death rates of eight cities in West South Central states from typhoid per hundred thousand of population

	1931–1935	1926–1930	1921–1925	1916–1920	1911–1915	1906–1910	1936	1935	1934
Tulsa	1.1	8.3	16.2*	....	....	....	0.7†	0.7	2.7
Houston	3.2	4.8	7.6	14.2	38.1	49.5*	3.8	2.2	2.8
San Antonio	4.2	4.6	9.3	23.3	29.5	35.9	2.7	3.3	4.9
Oklahoma City	4.3	7.4*	....	....	....	....	4.3†	2.5	5.9
Fort Worth	4.6	5.9	6.1	16.3*	11.9	27.8	3.3	1.2	5.9
El Paso	4.9	9.1	10.8	30.7	42.8	....	6.8†	7.6	3.8
Dallas	5.4	7.2	11.2	17.2	....	....	1.5†	2.9	4.3
New Orleans	9.6	9.9	11.6	17.5	20.9	35.6	6.5	7.4	8.9

* Incomplete data.

† Rate computed from 1930 census population, as no local estimate was given.

TABLE 8

Death rates of eleven cities in Mountain and Pacific states from typhoid per hundred thousand of population

	1931–1935	1926–1930	1921–1925	1916–1920	1911–1915	1906–1910	1936	1935	1934
Long Beach	0.2	1.1	2.1*	....	....	....	0.6	0.0	0.6
Seattle	0.6	2.2	2.6	2.9	5.7	25.2	0.5	0.8	0.0
Tacoma	0.7	1.8	3.7	2.9	10.4	19.0	0.9	0.0	0.0
Los Angeles	0.8	1.5	3.0	3.6	10.7	19.0	1.0	0.9	1.0
Portland	0.8	2.3	3.5	4.5	10.8	23.2	0.6	1.6	0.6
San Francisco	0.8	2.0	2.8	4.6	13.6	26.3	0.3	0.8	0.1
Oakland	1.0	1.2	2.0	3.8	8.7	21.5	0.3	1.7	0.7
Salt Lake City	1.0	1.9	6.0	9.3	13.2	41.1	0.0	1.4	1.4
San Diego	1.3	1.0	1.6	7.9	17.0	10.8	1.8	0.0	1.2
Spokane	1.4	2.2	4.4	4.9	17.1	50.3	0.8	0.8	2.6
Denver	1.8	2.6	5.1	5.8	12.0	37.5	2.0	0.7	1.4

* Incomplete data.

among nonresidents. Of the ten deaths in Atlanta, five are reported as nonresident. Being a hospital center for the surrounding area, the ratio of nonresident to total deaths in Atlanta has been high for many years.

TABLE 9

Death rates from typhoid in 1936

Honor Roll: No Typhoid Death (Eighteen Cities)

Bridgeport	Utica	Evansville
Somerville	Syracuse	Fort Wayne
Waterbury	Scranton	Chattanooga
Worcester	Tampa	Minneapolis
Cambridge	Norfolk	Duluth
Springfield	South Bend	Salt Lake City

First Rank: from 0.1 to 1.9 Deaths per Hundred Thousand (Fifty-Seven Cities)

Boston	0.1*	Pittsburgh	0.7†	Canton	1.0
Newark	0.2	St. Paul	0.7	Cleveland	1.0
Buffalo	0.3	Tulsa	0.7	Toledo	1.0†
Milwaukee	0.3	Providence	0.8	Los Angeles	1.0†
Chicago	0.3	Elizabeth	0.8	Youngstown	1.1†
San Francisco	0.3†	Erie	0.8*	New Haven	1.2
Oakland	0.3	Trenton	0.8*	Flint	1.2
New York	0.4	Camden	0.8	Jacksonville	1.3
Hartford	0.5	Akron	0.8†	Louisville	1.4†
Detroit	0.5	Indianapolis	0.8†	Albany	1.5
Kansas City, Mo	0.5	St. Louis	0.8	Dallas	1.5*
Seattle	0.5	Spokane	0.8	Washington	1.6
Jersey City	0.6*	Fall River	0.9	Peoria	1.7*
Rochester	0.6†	Baltimore	0.9	New Bedford	1.8
Grand Rapids	0.6*	Wilmington	0.9	Reading	1.8
Long Beach	0.6*	Omaha	0.9*	Dayton	1.8†
Portland	0.6	Tacoma	0.9	San Diego	1.8†
Paterson	0.7	Lynn	1.0	Cincinnati	1.9†
Philadelphia	0.7	Lowell	1.0	Wichita	1.9

Second Rank: from 2.0 to 4.9 (Fifteen Cities)

Denver	2.0	Miami	3.1†	Knoxville	4.1
Kansas City, Kan	2.3	Atlanta	3.2†	Oklahoma City	4.3
Richmond	2.7	Fort Worth	3.3	Nashville	4.4†
San Antonio	2.7	Columbus	3.7*	Memphis	4.7†
Des Moines	2.8	Houston	3.8	Yonkers	4.8

Third Rank: from 5.0 to 6.8 (Three Cities)

Birmingham	5.0	New Orleans	6.5†	El Paso	6.8†

*** All typhoid deaths reported were stated to be among nonresidents.**

† One third or more of the reported typhoid deaths were stated to be among nonresidents.

In the East North Central group the rate has again increased to approximately the average for the five year period 1931–1935, not as high however as occurred in 1934. There is in the group but one city with a death rate in excess of 2.0 and, as previously indicated, most of these deaths occurred in a hospital in Columbus. While in 1935 there were five cities in this group with no death, there are but three such cities in 1936, South Bend, Evansville and Fort Wayne. Equally impressive is the reduction in death rate in Evansville (4.7 in 1935, 0.0 in 1936). Nine cases with one death spoiled the admirable record of Grand Rapids, the source of infection being attributed to a bake shop. Cleveland reports that of nine deaths three occurred

TABLE 10

Number of cities with various typhoid death rates

	NUMBER OF CITIES	10.0 AND OVER	5.0 TO 9.9	2.0 TO 4.9	1.0 TO 1.9	0.1 TO 0.9	0.0
1906–1910	77	75	2	0	0	0	0
1911–1915	79	58	19	2	0	0	0
1916–1920	84	22	32	30	0	0	0
1921–1925	89	12	17	48	12	0	0
1926–1930	92	3	10	30	37	12	0
1931–3935	93	0	6	17	28	42	0
1930	93	2	6	30	23	22	10
1931	93	2	6	23	28	22	12
1932	93	1	7	13	29	29	14
1933	93	0	7	18	19	33	16
1934	93	0	9	11	27	23	23
1935	93	0	7	15	18	29	24
1936	93	0	3	15	21	36	18

in the Cleveland State Hospital for the Insane (it should be noted that the health department of Cleveland has included these deaths as residents while in Columbus the health department has recorded nine deaths that occurred in a state hospital for the insane as among nonresidents). Chicago continues to have a very low rate. Milwaukee and Detroit, although low, have not maintained the lower rates of 1935, in which year there was no death recorded in Milwaukee.

The six cities in the East South Central group, while having a lower rate (3.35) than in 1935 (3.94), and lower than the five year average for 1931–1935 (4.81), continue as a group to rank second only to the West South Central group, which has the highest rate

(3.99 in 1936). The actual number of typhoid deaths in this group dropped from forty-nine in 1935 to forty-three in 1936. Chattanooga reported no death. With the exception of Chattanooga and Louisville, all the cities had a death rate in excess of four. Louisville reports that of five deaths two occurred among nonresidents; of thirteen deaths in Birmingham, three were among nonresidents; of seven deaths in Nashville, six were among nonresidents; of thirteen deaths in Memphis, five were among nonresidents. This clearly indicates that the cities in this group are serving as hospital centers for the surrounding areas where typhoid continues to be prevalent. The freedom from typhoid in Chattanooga is in striking contrast to the high death rates of previous years.

The West North Central group reports substantially the same number of deaths in the past two years (twenty-two in 1936, twenty-three in 1935). The rate of 0.79 marks a new low for the group. Minneapolis and Duluth report no death. After two consecutive years with no death, Wichita reports two resident deaths. Des Moines, with a rate slightly in excess of that in 1935 but materially lower than that of 1934, continues to rank highest.

The eight cities in the West South Central group, after showing a marked improvement in their rate in 1935, have increased their rate slightly in 1936, there being seventy-nine deaths in 1936, seventy-four in 1935. The group rate of 3.99 is the highest for any group but is materially lower than the rate of 5.43 for this group in 1934 and the rate of 5.36 for the quinquennial average of 1931–1935. There were but two cities in this group with a rate less than 2.0 (Tulsa with 0.7 and Dallas 1.5). There were two cities with a rate in excess of 6 (El Paso with 6.8 and New Orleans 6.5). Of the four deaths reported for Dallas, all are stated to have occurred among nonresidents. The high percentage of nonresident deaths in El Paso and New Orleans has already been referred to. No reference is made by the health officer in any instance to an unusual prevalence or outbreak of typhoid. It is quite likely, as in the instance of the East South Central states, that the urban communities provide hospital facilities for the surrounding areas. Tulsa continues to have the lowest rate in the group, as it has had every year beginning with 1930.

The cities in the Mountain and Pacific states had a reduction in the rate below that of 1935, but not quite as low as 1934. Salt Lake City led the list with no death. There were but two cities with a rate in excess of 1 (San Diego and Denver) and there was no city

with a rate in excess of 2. Denver has the unenviable distinction of having the highest rate. Among thirteen deaths occurring in Los Angeles, six were among nonresidents. With two deaths in San

TABLE 11

*Total typhoid rate for seventy-eight cities, 1910–1936**

	POPULATION	TYPHOID DEATHS	TYPHOID DEATH RATE PER 100,000
1910	22,573,435	4,637	20.54
1911	23,211,341	3,950	17.02
1912	23,835,399	3,132	13.14
1913	24,457,989	3,285	13.43
1914	25,091,112	2,781	11.08
1915	25,713,346	2,434	9.47
1916	26,257,550	2,191	8.34
1917	26,865,408	2,016	7.50
1918	27,086,696†	1,824†	6.73
1919	27,735,083†	1,151†	4.15
1920	28,244,878	1,088	3.85
1921	28,859,062	1,141	3.95
1922	29,473,246	963	3.26
1923	30,087,430	950	3.16
1924	30,701,614	943	3.07
1925	31,315,598	1,079	3.44
1926	31,929,782	907	2.84
1927	32,543,966	648	1.99
1928	33,158,150	628	1.89
1929	33,772,334	537	1.59
1930	34,386,717	554	1.61
1931	35,137,915	563	1.60
1932	35,691,815	442	1.24
1933	35,691,815	423	1.18
1934	35,401,715	413	1.17
1935	35,401,715	348	0.98‡
1936	36,216,404	342	0.94§

* The following fifteen cities are omitted from this table because data for the full period are not available: Canton, Chattanooga, Dallas, Fort Wayne, Jacksonville, Knoxville, Long Beach, Miami, Oklahoma City, South Bend, Tampa, Tulsa, Utica, Wichita, Wilmington.

† Data for Fort Worth lacking.

‡ The rate for ninety-three cities in 1935 was 1.03 (total population 37,437,812, typhoid deaths 385), whereas in 1930 it was 1.64, and in 1933 and 1934 it was 1.24 and 1.25, respectively. The 1931–1935 average for the ninety-three cities is 1.31.

§ Rate for ninety-three cities in 1936 was 0.96 (total population 38,249,094, typhoid deaths 371).

Francisco, one was of a nonresident. With this correction for residence, both of the large California cities can boast of an enviable record. Tacoma, after two successive years of freedom from typhoid (the third in its history), reports one resident death.

THE HONOR ROLL

While in 1935 there were twenty-four cities on the honor roll with no deaths from typhoid, there were only eighteen in 1936. Among the cities with a rate from 0.1 to 0.9, the number increased from twenty-nine to thirty-six. This apparently shows the influence of

TABLE 12

Total typhoid death rate per hundred thousand of population for ninety-three cities according to geographic divisions

	POPULATION	TYPHOID DEATHS		TYPHOID DEATH RATES					
		1936	1935	1936	1935	1934	1931–1935	1926–1930	1925
New England	2,630,017	11	13	0.42	0.49	0.53	0.70	1.31	2.48
Middle Atlantic	13,291,916	74	72	0.56	0.55	0.63	0.80	1.40	2.97
South Atlantic	2,585,257	40	61	1.55	2.58	2.11	2.70	4.50	7.01*
East North Central	9,705,898	70	58	0.72	0.60	0.91	0.75	1.29†	2.32†
East South Central	1,283,423	43	49	3.35	3.94	4.91	4.81	8.31	13.00
West North Central	2,775,847	22	23	0.79	0.85	1.48	1.24	1.83	3.43
West South Central	1,979,575	79	74	3.99	3.82	5.43	5.36	7.32‡	13.08§
Mountain and Pacific	3,997,161	32	35	0.80	0.88	0.75	0.88	1.80	2.33

* Lacks data for Jacksonville and Miami.
† Data for South Bend for 1925–1929 are not available.
‡ Lacks data for Oklahoma City in 1926.
§ Lacks data for Oklahoma City.

one or two chance deaths from this disease. Bridgeport, Cambridge, Fort Wayne, Scranton, Somerville and Springfield were on the honor roll in both 1935 and 1936.

There were only eighteen cities in 1936 with rates of 2.0 or over, in contrast with twenty-two such cities in 1935 and twenty in 1934. In 1936 there were but three cities with a rate in excess of 5.0, as compared with seven in 1935 and nine in 1934. Comparing the cities by groups (table 12) it will be observed that the high rates are in the Southern States, the medium rates in the Pacific and Northern states, and the lowest rates on the North Atlantic Seaboard and in New England.

LOWEST RECORD REACHED

For the seventy-eight cities for which complete data are available since 1910, there occurred 342 deaths from typhoid in 1936, which is the lowest of record (348 in 1935). The rate for this group of cities is for the second consecutive year less than 1.0. The rate for the ninety-three cities studied in 1936 is also slightly below 1.0 (0.96). This statistical study shows a downward trend in the death rate from typhoid in the large cities of the United States. As a cause of death this disease is of little consequence in many parts of the country. It is believed that in many urban areas, especially in the South, the prevalence of typhoid in surrounding rural areas materially handicaps the large cities in attaining more promptly a lower death rate from typhoid.

CORRECTION

Refer to the June Journal and the article by Russell E. Barnard entitled "Wall Thicknesses of Steel Pipe."

On Page 804, just below figure 1, the phrase "Multiply P by K to obtain bare wall thickness" should read "Multiply P by F to obtain bare wall thickness." 'F' is the area-safety factor to which reference is made on page 803.

On page 805, the phrase "Values of C/K for 6″ pipe" should likewise be corrected to read "Values of C/F for 6″ pipe."

Please enter the corrections at the point in the original article.

ABSTRACTS OF WATER WORKS LITERATURE

Key: JOURNAL of the American Water Works Association, 29: 10 (1937). The figure 29 refers to the volume, 10 to the page of the JOURNAL and (1937) to the year of issue. If volumes of a publication are not paged consecutively but by issues, the figures 29: 1; 10 (1937) indicate—volume 29, number 1, page 10 and 1937 as the year of issue. Initials *W. P. R.* signify that abstract is reproduced, by permission, from *Water Pollution Reports (British)*.

WATER SUPPLY—GENERAL

Drainage Basin Problems and Progress. ABEL WOLMAN. Eng. News-Rec., 118: 476 (1937). Salient features of reconnaissance of nation's water conservation problems made by Water Resources Committee of National Resources Committee and published in its summary report are discussed. A group of investigative and construction projects, using the major river systems as basis, were suggested, total cost approximating $3,771,000,000, i.e., $300,000,000 to $500,000,000 annually over period of 6–10 years. Details of distribution of project costs by types and districts are shown in tabulation. Regardless of whether Congress provides changes in administrative management, report should be useful in (a) providing reservoir of desirable and beneficial projects; (b) focusing attention for discussion and criticism on tentative national program; (c) disclosing possible conflicts of interest and reconciling some; (d) establishing to an unexpected degree close working relations between federal and state agencies concerned with water use and control; (e) pointing out deficiencies in existing information; and (f) extending horizon of water use and control from the specific project to the basin plan. Extension of the investigation, the committee's next endeavour, must come through joint efforts of state and federal agencies with wholehearted cooperation of engineering profession. Such extension has been started in some regions through assignment of water technicians and consultants to state and regional planning agencies—*R. E. Thompson*.

Industries Cooperate with City to Build a Separate Water Supply. ANON. Eng. News-Rec., 118: 591 (1937). Independent water system for industrial uses in Birmingham, Ala., is being built by city under arrangement whereby number of industries signed contracts before construction was started to purchase sufficient water to guarantee payment of the bonds. Project, costing nearly $6,000,000, includes 22 billion-gallon impounding reservoir on Blackburn fork of Warrior river, where earth and rockfill dam 185 feet high and 1500 feet long is being constructed, and 39-mile, 60-inch welded steel pipe line which will convey the water to distribution system made up of 16- to 24-inch cast iron pipe. About midway in pipe line, 120-million gallon storage reservoir is being constructed to provide uniform gravity pressure, afford factor of safety in case

of breakdown and permit intermittent pumping from impounding reservoir. Present supply is ample for domestic purposes but is inadequate to meet industrial demands.—*R. E. Thompson.*

Kitchener Water Works Sets New Records During 38th Year Under Municipal Control. Marcel Pequegnat. Eng. Con. Rec., 50: 7 (March 17, 1937). Details of operation during 1936 are given. Average consumption was just over 3 million gallons per day, exceeding that of 1935, the former record, by 8%. Per capita consumption averaged 94 gallons per day. Over 99.5% of all consumers are metered. Financial conditions are excellent. Tabulation is included showing chemical composition of water supplied. Bacteriological examination gave "A" classification, i.e., *E. coli* absent in 50 cc. Diesel engine-generator unit was installed at Strange Street station, permitting accurate control of purchased power peak.—*R. E. Thompson.*

Practical Methods for Condensation of Water from the Atmosphere. W. Klaphake. Soc. Chem. Ind., (Victoria) 36: 1093 (1936). Rainfall, dew formation and the absorption of atmospheric moisture by the soil are discussed and methods used to produce rain and to obtain water supplies from the atmosphere are reviewed. Reference is made to the collection of dew on mountain slopes smoothed with clay and covered with straw, and the construction and operation of dew ponds and of walls, subterranean passages and buildings for condensing water from the air. Many types of building were tried in Yugoslavia. That finally adopted was a sugarloaf shaped building, about 50 ft. high, with walls at least six feet thick with holes on the top and at the bottom, and the inner surface enlarged by a network of walls of a material with a large surface. The outer wall is of concrete and the inner surface of limestone or other porous material. During the day warm air, drawn through the upper holes into the building by the out-flowing cooler air, is cooled on the cold surface and deposits its water. The essential factor in obtaining water from the air is a large water-condensing surface protected against the heat of the sun. The air should pass to the condensing surface slowly so that it may cool properly and deposit its water. A big heap of stones would have the same effect as the buildings. This process should be applicable under Australian conditions. Reference is made to the work of Knapen, A., who has invented a device for drying wet walls of buildings.—*W. P. R.*

The Water Supply of Buenos Aires. B. Raffo. Ingenieria, 38: 140 (1936). Whole river-water supply is treated at Palermo works in settling tanks, in which alum is applied, slow sand filters operated at rate of 25 centimeters per hour, and rapid sand filters operated at 4 meters per hour. Filters are cleaned once each day. Filtered water is chlorinated. Normal daily consumption is 1.1 million cubic meters or 500 liters per capita.—*R. E. Thompson.*

Water Purification in Cape Town. T. P. Francis. S. African Eng., 46: 132 (1935). Water supply, derived from 5 impounding reservoirs on top of Table Mountain and from one on Steenbras River, is highly colored by peat acids and treatment is being considered. Experimental plant installed to treat

water supplied to part of Wynberg includes 2 rapid gravity filters and 1 pressure unit. Treatment includes mixing, coagulation, sedimentation, filtration, lime treatment and chlorination: color is reduced 97% and harmful bacteria are eliminated. Experiments on coagulation with iron and aluminum salts showed that the precipitates in lower pH range contain basic sulfates in addition to hydroxides. As coagulation is effected by neutralization of electrically charged particles and these are more numerous in water which has been stored, colored water is easier to treat after storage. Optimum pH for color removal by alum was found to be 4.9. Alum salts gave better results than ferric salts. Organic substances combined with the iron forming highly colored compound which was difficult to coagulate: addition of sodium aluminate (Alfloc) was essential when iron was used. Water coagulated with alum at pH 4.9 requires lime treatment to raise pH to 9.5 prior to distribution. On average, 2.3 grains alum per gallon are used, about 0.38 grain of lime (CaO) per gallon being added to react with alum and give pH of 4.9 and then, after removal of precipitate, 0.55 grain of lime per gallon to raise pH to 9.5.—*R. E. Thompson.*

City of Plymouth Water Supply. W. and W. Eng., 38:531 (1936). The water supply of Plymouth is collected in storage reservoirs mainly from the upper reaches of the Rivers Meavy and West Dart and delivered to the Belliver and Roborough service reservoirs. It then flows to the Crown Hill reservoirs, and passes through slow sand filters to the gravity distribution system. All new mains and mains which have been flushed are sterilised with chlorinated water before use. For the control of algae in the reservoirs and also for protection, as the system is opened to the atmosphere at places, ammonia-chlorine treatment is applied to the water at the Belliver and Roborough reservoirs. Chlorine is always present in the Crown Hill reservoirs and the reservoirs are clear of algal growths.—*W. P. R.*

A New Water Supply for Innisfail, Queensland. JACK MULHOLLAND. Am. City, 52:6; 79 (1937). Innisfail is situated on the north coast of Australia at the mouth of the North Johnstone River. The new supply is pumped from this river to a filtration plant where alum and lime are added. From the sedimentation basins and filters the water is pumped to an elevated concrete reservoir from which it flows to the distribution system. All pumping is remote-controlled from the filtration plant. Approximately one-half the cost of the project was paid from unemployment relief funds.—*Arthur P. Miller.*

Developing a New Water Supply for Los Angeles. ANON. Eng. News-Rec., 118:285 (1937). Owens Valley aqueduct, built during period 1907–13 at cost of $24,000,000, includes some 250 miles of canals, conduits, tunnels and steel siphons. Original design provided for capacity of 436 second-feet: in recent years, owing chiefly to improved flow coefficients, as much as 505 second-feet has been delivered. Important function of aqueduct is development of electrical energy at power drops. Additional sources are now being developed in next watershed, Mono Basin, about 100 miles north, which will add dependable continuous flow of 150 second-feet from high altitudes on east side of the Sierra Nevada. Water rights were secured by purchase and condemnation. Water

of Mono Lake is practically saturated with salt, derived from earth formations in the volcanic region and not from inflowing waters: runoff from higher levels must therefore be diverted above lake. Development program contemplates diversion of streams into Grant Lake reservoir. Outlet tunnel from reservoir is about 3,500 feet long and will deliver into 500-second-foot canal extending 4 miles to west portal of 11.3-mile Mono Craters tunnel. Unlined canal will be built to convey water from east portal to Long Valley Dam, 17 miles downstream, from reservoir behind which the water will be released into natural stream channel in which flow will continue to Owens Valley aqueduct intake. Ultimately, development will require additional diversion dams and conduits to bring in flow of tributary streams not now included. Grant Lake Dam, forming 48,000-acre-foot reservoir, will be 640,000-cubic yard earthfill structure with maximum height of about 90 feet and crest length of 750 feet. Long Valley Dam, 1,045,000-cubic yard earthfill, will be 167 feet high, of which 50 feet will be below streambed level. Crest length will be 550 feet and base thickness 870 feet. Reservoir capacity will be 163,000 acre-feet. Stripping at original site disclosed creviced rock and a fault, necessitating shifting location 0.5 mile upstream. Mono Craters tunnel passes under extinct volcanic craters, formation being very broken and varying widely from tuff through more or less cemented gravel to rock of varying degrees of hardness. Tunnel section, inside unreinforced, 6-inch, concrete lining, is 9 feet high and 9 feet, 7.5 inches wide. Considerable amount of carbon dioxide, in water entering under pressure, has been encountered. Methods of handling gas to maintain content of less than 2% in tunnel air are described. Carbon dioxide escaping via west portal, in air and water, is about 450 cubic feet per minute. Considerable difficulty with water, quicksand and development of high pressures has been experienced in sinking one of shafts (No. 1), necessitating use of steel sheet piling and high pressure grouting. Cost of water rights, etc., was about $5,000,000 and construction costs are estimated at $13,000,000. Over all cost of driving and lining tunnel is estimated at $100 per linear foot. Work is being carried out entirely by city forces. Project will permit development of additional power both at new plants and at the existing plants at lower end of Owens Valley aqueduct.—*R. E. Thompson.*

Report of Water and Light Department, Topeka, Kansas. 1936. 38 pp. (1937). Very complete operating statistics are given in graphical and tabular form, together with comments on quality of water supplied and purification effected. Supply is derived from Kansas River (85%) and wells (15%). Treatment employed consists of lime softening, alum coagulation, recarbonation, filtration and chlorine-ammonia sterilization. Soda ash and activated carbon are used intermittently for reduction of non-carbonate hardness and tastes and odors, respectively. Average chemical dosages in 1936, on basis of water treated, were as follows: lime 10.03, alum 1.14 and soda ash 1.19 grains per gallon, chlorine 0.71, ammonia 0.10 and activated carbon 1.20 p.p.m., respectively. Total hardness was reduced from average of 284 to 95 p.p.m. It is estimated that softening effects average saving of about $9.00 per year per family of 5, approximately equivalent to average domestic yearly water bill. One pound of lime costing 0.5¢ will soften as much water as $3.00 worth of soap. Water

supplied conformed to all requirements of Treasury Department standard: *E. coli* index per 100 cc. was zero. Iodine content is about 0.5 part per billion. It is of interest to note that fluorine content was reduced from 0.72 to 0.40 p.p.m. by routine treatment employed. Wash water used averaged 1.38% and water for basin flushing 1.24%. Cost of purification averaged $18.34 and total cost of supplying water, including interest and depreciation, $195.91 per million gallons; net revenue per million gallons was $226.47. Average revenue exceeded expenses by $58,792.70. Population is 73,677. Water-borne typhoid rate has been zero for some years.—*R. E. Thompson.*

Water Resources of Texas. JOHN W. PRITCHETT. Civ. Eng., 7: 462 (1937). The state covers an estimated area of 265,890 sq. mi., about 3,500 miles of which are water. The run-off of Texas streams is in the neighborhood of 42,980,000 acre-feet per year. It is estimated that the streams have a flow and gradient sufficient to develop one-half million horse power during six months of the year. In the near future the total installed capacity of hydroelectric generators will amount to 119,810 kw and a possible total capacity of 221,210 kw may be anticipated when the Colorado and Brazos projects are completed. Some sections of Texas are noted for large perennial springs, the most important of which occur along the Balcones escarpment between the cities of Austin and Del Rio. Ground water, in the long run, will prove to be the most valuable underground resource of Texas. The search for ground water supplies in undeveloped areas has scarcely been started, but it is indicated that large supplies are available in several new areas. A grave situation exists in regard to the division of the water of the Rio Grande between the United States and Mexico, and it is most important that a treaty on this subject be negotiated as soon as possible.—*H. E. Babbitt.*

German Water Supplies. HAYO BRUNS. Gas- u. Wasserfach, 79: 517 (1936). Various German water supply sources are discussed. Much of the "ground water" is really from bank filtration from streams, etc. Employment of rapid sand filtration and chlorination has resulted in decreased use of slow sand filtration, but former method is not entirely safe for badly polluted waters. Laboratory control is essential for safe operation, irrespective of method of purification employed. Suitability of springs as source of supply is discussed. Flow should not vary greatly after rains and possible sources of contamination on watershed should be investigated. Wells for fire protection in large cities in case of aerial attack should be strictly supervised to prevent use of water for drinking purposes. Statistics show steady decline in typhoid case and death rates in Germany.—*R. E. Thompson.*

German Materials for Water Works Construction. E. NAUMANN. Gas- u. Wasserfach, 79: 674 (1936). Porcelain, glass and chromium-manganese steels have been successfully used for well filters. Bell and spigot joints can be packed with bitumen-impregnated aluminum wool or iron sponge. Small sizes of pipes for very aggressive waters may be made from stoneware, glass, porcelain, etc.; special "pressure" joint is illustrated. Aluminum and synthetic resin pipes have been used, but experience with these is inconclusive.

Cast iron and steel pipes should be protected other than with coal tar, which becomes brittle. Suitable coatings might be made from brown-coal tar or asphalt.—*R. E. Thompson.*

STERILIZATION

Electric Purification of Water. M. de Lipkowski. La Tech. Sanit. et Municip., 32: 3, 54 (1937). Ozonization is but one of a number of methods which have been used for sterilizing potable water. Owing to the fact that at the same time it also removes iron, eliminates tastes and odors, and decolorizes, it may be justly regarded as a purification process; hence the title of this paper. Pure ozone gas is of a dark blue color; liquid ozone is indigo blue, is a formidable explosive, and boils at about − 112°; the dark crystalline solid melts at about −250°. Otto in 1899 was the first to devise a method for its practical production on a commercial scale. Air or oxygen is submitted to the action of the silent electric discharge, causing some of the oxygen to condense to ozone, O_3. Metallic plates are the usual electrodes and sheets of glass the usual dielectrics. Double refrigeration is necessary except for small installations. Illustration is given of one of most powerful ozonators in use, capable of sterilizing 825 cubic meters (200,000 gallons) an hour. It is two stories high and contains 20 elements of 50 square decimeters (5 square feet), or 10 square meters (100 square feet) in all. Alternating current of high frequency and at high potential is necessary. Otto's condition, other things being equal, for maximum production of ozone is that the oscillation following each impulse shall have died down at the exact moment when the succeeding impulse is received. In practice, for small installations 50-cycle current (ordinary commercial current) is suitable. For large installations, from 500-cycle up to even 10,000-cycle. The higher the frequency, the greater will be the concentration of ozone; but the power expended per gram of ozone formed is nearly independent of the frequency. One gram-molecule of ozone requires for its formation 29.6 calories, or, in round numbers, 425 × 29.6, or 12,580 kilogram-meters. One horse-power hour (metric) can produce therefore about $\frac{270,000}{12,680}$ 48, or 1,030 grams of ozone. In practice it is found that an ozonator of two dielectrics consumes 17 watt-hours in the generation of one gram of ozone. It has also been found that the average water requires for its sterilization with ozone an expenditure of 7.5 watt-hours per cubic meter (28.5 kilowatt-hours per million gallons), which means that 0.5 gram of ozone per cubic meter (1900 grams per m.g.) is sufficient for sterilization. This cannot be regarded as a prohibitive cost; with current at 10 centimeters a kw.-hr., it is only 0.75 of a millime per cubic meter (or, reckoning the franc at 4.2¢, 12¢ per m.g.). If current has to be generated from thermal source and costs 30 centimes per kw.-hr., above figure must be tripled; even then, it is of the order of 2 millimes per cubic meter (35¢ per m.g.). A simple method is given for the determination of gaseous ozone. Ozone is applied by introducing ozonized air into the water to be treated; either by a so-called emulsifier (which acting on injector principle sucks the air into water stream), or by a blower. In either case, ozonized air and water supply are introduced at bottom of vertical tank known as "con-

tact column" which should be at least 5 meters (16.5 feet) deep and of sufficient capacity (i.e. one-fifteenth of the hourly capacity of the plant) to allow a contact period of at least 4 minutes, which has been established by experience as necessary and sufficient. The water overflowing from the contact column enters the desaturator where it cascades into another tank of smaller size, thereby losing most of its excess ozone, wherefrom it is taken into the distribution system. Water leaving the contact column with any excess of ozone must necessarily be sterile; and as this is instantaneously determinable by any unskilled person (potassium iodide and starch test) the control is supremely simple. Perfect quantitative control can be obtained if desired by electrical methods. Water with ozone present in excess differs slightly in potential from the same water before treatment with ozone, the difference increasing with excess of ozone. Automatic indicators and recorders are available by which a continuous check-up is obtained; moreover they sound an alarm and cut off the supply should the water fail to show excess of ozone. Ozonators are available for small requirements; a 30-watt size for 150 liters (40 gallons) an hour, a 100-watt for 500 liters (130 gallons), and a 200-watt for 3000 liters (800 gallons) illustration of which is given. Illustrations are given of typical public supply systems of different capacities. Yainville is a small working-class village; capacity of plant, 5 cubic meters (1300 gallons) an hour. Essones is a moderate-sized town of between 10,000 and 15,000 population, served by plant with capacity of 100 cubic meters (25,000 gallons) an hour capacity, but in duplicate, as a stand-by, so that if the necessity arose, 200 cubic meters (50,000 gallons) an hour could be supplied. The city of Nancy uses 100,000 cubic meters (25,000,000 gallons) per day. The raw water contains from 3 to 16 mgms. of organic matter and from 1000 to 3000 *E. coli* per liter. After filtration and ozonization no pathogenic germ, no *E. coli*, and no putrefying bacteria have ever been detected. The number of harmless bacteria present is always less than 10 per cc. The city and arsenal of Toulon were for many years inadequately supplied with water; but at length an ample source was found in hilly country at elevation 271 meters (889 feet). The energy of the water in its descent is utilized to generate the ozone needed for its purification. The daily capacity is about 60,000 cubic meters (16,000,000 gallons). The cost of the project ran to 70,000,000 francs (about $3,000,000). This interesting system is well illustrated. Paris, which already ozonizes 90,000 cubic meters (24 m.g.) daily at St. Maur, has decided to increase this quantity to 300,000 cubic meters (80 m.g.) daily. From every city where ozonization is practised, water-borne disease has practically disappeared. There was one such, Nice, in 1906; there were 75 in 1933; to-day there are 101.—*Frank Hannan.*

Report of a Series of Tests Performed to Ascertain the Efficiency of the Ammonia-Chlorine Treatment of Water Applied by a Standardized Method. E. F. W. Mackenzie. J. Royal Army Med. Corps, 66: 217 (1936). New method of water purification for army use consists of adding to 100 gallons of water 0.7 gram ammonium chloride in solution followed by 4 grams of "chlorosene" previously made into a paste. In relatively pure water, 0.2 p.p.m. chloramine failed to kill *E. coli* in 1 hour but did so in 2 hours: same amount of chlorine killed *E. coli* in 30 minutes. The ammonia-chlorine treatment provides titrat-

able chlorine residual which persists longer than in case with chlorine alone. After period of 24 hours, chloramine residual of 1.0 p.p.m. failed to kill added *E. coli* at 0°. Freshly prepared chloramine killed *E. coli* in 15 minutes but after standing 35 minutes the solution did not kill in 30 minutes but did in 1 hour. In presence of urine and fecal matter both chloramine and chlorine at 1.0 p.p.m. failed to kill *E. coli* in 2 hours. In water artificially polluted with cow manure, chlorine was somewhat more effective in destroying *E. coli* than chloramine. It is suggested that bacteria became embedded in chloramine-resistant particles. Chlorine was also superior in water of pH 9.0 with total hardness of 320 p.p.m. Neither iron rust nor sunlight had any adverse effect on action of chloramine in slightly alkaline waters. Chloramine was more effective in removing objectionable tastes and odors from water than was chlorine.—*R. E. Thompson.*

Field Chlorination of Water: Factors Influencing the Use of Stable Calcium Hypochlorite in the Water-Sterilizing Bag. LEON A. FOX. Military Surgeon, 78: 329 (1936). Present standard procedure is: (a) hyperchlorination checked by *o*-tolidin test, (b) 30-minute contact period, (c) dechlorination with thiosulfate. Extensive experiments were carried out to determine effectiveness of chlorination after 5-, 10- and 30-minute contact periods. Contaminations in excess of 100,000 organisms (*Es. coli*) per cc. were used; chlorine residuals were checked with Enslow-LaMotte comparator; sampling took place at accurate intervals of 5, 10 and 30 minutes; and chlorinating medium was Matheison H. T. H. (stable hypochlorite containing 65 per cent available chlorine). Conclusions: (1) Germicidal action of calcium hypochlorite is very prompt; less than 5 minutes contact time is required for destruction of intestinal Gram-negative bacilli when adequate residual chlorine is present. (2) Organic matter interferes to greater extent than any other factor encountered in natural waters. (3) Suspended matter interferes, but to lesser extent than organic matter. (4) In absence of organic matter and other chlorine-consuming substances, hypochlorite is extremely bactericidal to Gram-negative bacilli. In distilled water, purposely contaminated, concentrations as low as 0.1 p.p.m. chlorine destroy promptly. (5) Greater bactericidal action results from direct addition of hypochlorite than from addition of solutions of hypochlorite, even when residual chlorine is same. (6) The *o*-tolidin test does not indicate germicidal chlorine present; residual tests in presence of organic material and suspended solids do not indicate germicidal activity equal to that shown by same readings in absence of such interfering agents. (7) Experimental data indicate that present practice of denying troops access to hypochlorite-treated water until 30-minute contact time has elapsed is not justified; it is recommended that contact period be reduced to 10 minutes. Seventeen references.—*R. E. Thompson.*

The Sterilization of Water with Chlorine Dioxide. ANDRÉ LESEURRE. Bull. sci. pharmacol., 43: 713 (1936). For generation of chlorine dioxide, 100 parts of potassium chlorate and 150 parts of oxalic acid ($2H_2O$) are each mixed with 100 parts of diatomaceous earth. Immediately before use, the 2 mixtures are mixed and slowly added to 600 parts of sulfuric acid (436 B°.); 10,000 cubic

meters of water require 2 kilograms chlorine dioxide during 8 hours.—*R. E. Thompson.*

Some Notes on Water Sterilization in a Tropical Climate. J. S. Boissier. Wat. and Wat. Engng., **38**: 573 (1936). The water supplies of the State of Perak, Malaya, are generally chemically satisfactory but bacteriologically they fall far below the required standard. Some supplies are mechanically filtered; these plants are generally efficient but slow sand filter plants, except in the case of a few large supplies, are unreliable for bacterial removal. Chlorination has been used for many years but the supplies all discharge into open service reservoirs and, as under tropical conditions chlorine rapidly disappears, the condition of the water deteriorates. The condition of several supplies after chlorination is shown in tables and discussed. In practically every supply ammonia is now used along with chlorine and the results of analyses show that the required standard can always be maintained by this method. The advantages of ammonia-chlorine treatment are discussed. In some cases ammonia is added after chlorination and in one case pre-formed chloramine is used. The apparatus and methods generally adopted are described (see W. P. R. Summary, 1936, 9, Abstr. No. 516). Ammonia is generally used as sulphate and the proportion of ammonia to chlorine is 1:4. Chloride of lime is frequently used owing to the difficulty of supervising the use of gas cylinders. Ammonia-chlorine treatment has also been applied to an open-air swimming bath. No evidence of control of algae by the ammonia-chlorine treatment has been found.—*W. P. R.*

Processes for the Removal of Lead and Copper from Drinking Water. K. Koll. Tech. Sanit. Munic. **31**: 140 (1936). Lead may occur in drinking water as the result of solution from lead pipes or it may be present in the ground water. The first cause may be prevented by forbidding the use of lead pipes for water supplies. A wad of cotton wool or filterpaper in a pipe will remove lead from several litres of water if the content of lead is not more than 0.1 mg. per litre. Activated carbon is more efficient. Berkefeld filters will remove lead from water containing more than 1 mg. per litre provided it is not rich in chlorides. The filters may be regenerated by washing with 6 percent acetic acid. For treating large quantities, filters of granular magnesium oxide (Magnofilters) are successful; they remove the lead as carbonate and reduce the acidity of the water. Small quantities of copper may be present in water from pipes or as a result of disinfection with a copper salt. This may cause an unpleasant taste and is undesirable for washing. Magnesium oxide filters are equally suitable for the removal of traces of copper.—*W. P. R.*

Absorption of Chlorine by Water in a Packed Tower. F. W. Adams and R. G. Edmonds. Ind. Eng. Chem. **29**: 447 (1937). Solubility of chlorine in water is computed for partial pressures of chlorine from 0 to 5000 mm. of mercury and temperature range of 0 to 110°C. From these values, absorption coefficients are calculated for an experimental coke-packed tower operating between 38 and 50°F, at gas velocities between 0.78 and 1.93 lb./min./sq. ft. and with liquid velocities of 32 to 111 lbs./min./sq. ft. Results show that

under these conditions absorption is controlled by resistance of water film, and that coefficient of absorption is proportional to 0.8 power of water velocity.—*Selma Gottlieb.*

Bactericidal Action of Mercury on Escherichia Coli in Running Water. M. LISBONNE AND R. SEIGNEURIN. Compt. rend. soc. biol., 122: 18 (1936). Water was allowed to flow continuously into small tank so arranged that inflow was forced under surface of pool of mercury on bottom of tank. Effluent contained bacteria at first but was sterile after several days of continuous operation.—*R. E. Thompson.*

Chicago's Modern Chlorinating Plant. A. E. GORMAN AND H. H. GERSTEIN. W. W. and Sew., 83: 451 (1936). Chlorinating plant in new 300 MGD. Cermak Pumping Station is described. Only four chlorinators are used, to simplify piping arrangements, and each can feed 2000 pounds per day. Water supply to machines is in triplicate. Double ventilation system is provided, and in addition, there is a caustic soda tank for immersion of leaking one-ton chlorine containers.—*H. E. Hudson, Jr.*

New Ozone Water Works. A. SALMONY-KARSTEN. Tech. Gemeindeblatt, 39: 58 (1936). Siemens system is described. After passage through settling basins, treatment with alum and filtration, water is sterilized by bubbling ozone-containing air through it in towers 4–5 meters high. Units described produce 600 grams ozone per hour, sufficient to sterilize 400–600 cubic meters of water.—*R. E. Thompson.*

Quantitative Relations Between Germicides and Bacteria, and a Contribution to the Knowledge of Germicidal Action. CHOKUICHI MIYAKAWA. Japan J. Exptl. Med. 13: 661 (1935). Action of various chlorine germicides on *Es. coli* and *B. subtilis* was studied quantitatively, together with modifications of germicidal action due to protein substances. Author concludes that adsorption is concerned in combining available chlorine with bacteria, and that a subsequent chemical reaction with cell constituents evolves chloramine. Germicidal action of chlorine ion and of oxidative processes cannot be excluded. It seems probable that they are the main sterilizing agents with the less resistant bacteria, and that formation and action of chloramine become important only with more resistant organisms.—*R. E. Thompson.*

Superchlorination and Dechlorination of Water Supplies. H. PICK AND TH. GRUSCHKA. Gas- u. Wasserfach, 79: 365 (1936). From bacteriological standpoint, it is impossible safely to determine amount of chlorine required on basis of chemical tests. While curves of Nachtigall and Ali are of assistance, entire dependence cannot be placed upon them. For water of rapidly varying condition, and especially with rapidly varying organic matter content, superchlorination is simple and valuable solution of problem. True high-chlorination, as described by Adler, should be limited to chemically conditioning water for iron and aluminum removal. Either of these processes require use of suitable automatic dechlorination method. Of 2 processes available, granular

activated carbon and the Katarasit method, only former has been employed long enough for operating results to be available from variety of installations. Capital and operating costs are low.—*R. E. Thompson.*

The Bromination of Swimming Pool Water. H. HILDESHEIM. Tech. Gemeindeblatt, 39: 56 (1936). Bromination of water of swimming pool of 327 cubic meters capacity and 162 square meters surface in which water was maintained at 20–22° and which accommodated about 400 bathers daily is reported. When water was changed (once each week), bromine was added to amount of 3 p.p.m. As bromine is more soluble than chlorine, its application is simpler. Appreciable amount of bromine combined with organic matter present; morning following day of application, residual of only 0.9 p.p.m. free bromine remained, which dropped to zero by evening. Bacterial count increased from 0 to 8,000 by end of week; *Es. coli* was negative for 3 days, then positive. When original dosage was increased to 4 p.p.m. and small additional amount added each day to maintain slight residual, bacterial count increased only to 2,500 during week, *Es. coli* remaining negative. When bromine residual of 0.2 p.p.m. was maintained, water remained sterile.—*R. E. Thompson.*

Recent Developments in the Treatment of Swimming Bath Water. R. L. RANKIN. Surveyor, 89: 289 (1936). Objections to chlorine process, to ultraviolet-ray system and to ozone treatment have been overcome by use of electrocatadyn system. This method is used at Wallasey for pool containing 800,000 gallons of water. Small amount of water is strained, filtered, aerated and by-passed through activator. Silver enters water from electrodes, dosage being proportional to current flow. Excellent results are being obtained at very small cost.—*R. E. Thompson.*

Purification of Swimming Bath Water. A. M. N. PRINGLE. Munic. Eng., Sanit. Rec. 97: 322 (1936). Experiments at Ipswich indicate that satisfactory conditions can be maintained by aeration, filtration and chlorination (residual chlorine not less than 0.5 p.p.m.). If required, the whole of the water can be treated every 3 hours.—*R. E. Thompson.*

New Filtration Plant at Springfield, Illinois. ANON. Eng. News-Rec., 117: 673 (1936). High-speed lime softening and coagulation is outstanding feature of new softening and filter plant placed in operation on October 17 at Springfield as part of program that included 7-square mile artificial lake, power plant, and water treatment plant. Source of supply for years had been Sangamon River, 7 miles north of city. Increased supply being necessary, new source was created by damming Sugar Creek about 3 miles south of city. Lake formed has shore line of 70 miles and impounds 21 billion gallons of water, being largest artificial body of water in Illinois. Softening and filter plant has nominal capacity of 12 m.g.d., subject to 25 per cent overload, provision having been made for ultimate increase in capacity of 300 per cent. Hardness is reduced from 160 to about 75 p.p.m. Research by Charles H. Spaulding ledto economical design of coagulation and settling tanks in which better results can be secured in 1.5 hours than in 6 hours at old plant. Recarbonation is effected

with stack gas. Other features of plant include pneumatic conveyor system for lime, air conditioned laboratory, and electric heating system for entire plant, using off-peak power. Lake and reservoir project, which cost $2,500,000, was financed by bond issue to be retired from earnings. Grants and loans of $1,300,000 were received from government to aid in financing remainder of project, which cost $1,783,00.—*R. E. Thompson.*

WATER QUALITY

Report of the King Institute of Preventive Medicine, Guindy (India) for the Year Ending 30th September, 1935 (1936). C. G. PANDIT. Tabulated data regarding the work carried on in the Institute during the year, including results of analyses of various water supplies, are presented and discussed. Observations on one supply proved conclusively that cholera bacteriophage could be added to supplies which are systematically chlorinated, provided addition is made 0.5 hour after chlorination when there is no excess chlorine remaining. In experiments carried out to ascertain whether filarial infection with *W. Bancrofti* may be contracted by means other than the bite of the mosquito, it was demonstrated that the larvae were able to live in tap water 4.5–6.5 hours and withstand concentration of hydrochloric acid (0.2%) similar to that in gastric contents for 20–45 minutes. Results of experiments on Katadyn process of water sterilization were not uniformly satisfactory in regard to removal of coliform bacteria. After 6 months' use, Katadyn pellets used as filtering medium had lost ⅓ of their silver content. Experimental sand filters with thin sandwiched layer of granular activated carbon are still yielding satisfactory results on the Madras supply after having been in use over 2 years. Carbon contact units are also giving satisfactory results in purification of swimming pool waters. In series of experiments on use of minimal doses of chlorine in conjunction with vigorous agitation, claims of Bunau-Varilla were substantiated, minimal dose (0.1 p.p.m.) being as efficient as ascertained optimum dose (0.4–1.3 p.p.m.) in producing water containing no lactose-fermenting organisms in 60 cc.—*R. E. Thompson.*

The Hygienic Significance of the Occurrence of Lead in Drinking Water and the Colorimetric Determination of the Lead. HAYO BRUNS AND KARL HEINZ TÄNZLER. Gesundh.-Ing., 59: 485 (1936). Factors affecting solubility of lead in water (presence of oxygen, carbon dioxide, etc.) are briefly discussed, together with symptoms of lead poisoning in human beings. For colorimetric determination of small amounts of lead in drinking water, method of Gad is believed by author to be superior to that of Winkler, color developed being about twice as intense and solution clear and free from the colloidal sulfur often present when latter method is employed. Amounts less than 0.1 milligram per liter can be detected by method of Gad, but color is so faint that less than that amount cannot be satisfactorily estimated.—*R. E. Thompson.*

Unsuspected Copper in Domestic Water Supplies. DAVID W. HORN. Am. J. Pharm., 108: 320 (1936). Finding of unsuspected copper in domestic water supplies involving use of combined air and water pumps and copper pipe is reiterated. Simple test for copper is as follows: Fill white enamelware bucket

with the suspected water. Holding a cake of "Ivory" soap (or probably any other white soap) in the hand, agitate the water with the soap until blue color, if any, develops. One p.p.m. of copper will cause development of appreciable blue color; 0.5 p.p.m. is detectable. Attention is called to fact that there is a difference between intermittent and long-continued dosage with salts of heavy metals. The difference suggests a logical fallacy in unqualifiedly applying standards for water on interstate carriers to domestic waters which are consumed several times each day over extended period of residence.—*R. E. Thompson.*

The Value of the Presence of Bacteriophage in Waters as a Measurement of Their Quality. E. Couture. Rev. hyg. méd. prévent., 58: 371 (1936). Examination of different types of water for bacteriophage revealed no definite correlation between its presence and the potability of the water.—*R. E. Thompson.*

Mottled Enamel in the Salt River Valley and the Fluorine Content of the Water Supplies. H. V. Smith, Margaret Cammack and E. Osborn Foster. Ariz. Agr. Expt. Sta., Tech. Bull., 61: 373 (1936). Effects of various concentrations of fluorine on human teeth are detailed. From 0 to 0.8 p.p.m. fluorine in drinking water produced no noticeable effect; 0.9 p.p.m. usually produced very mild mottled enamel; 1.0–2.0 p.p.m. produced mild to moderate mottling; 2–3 p.p.m. produced moderately severe mottling; 3–6 p.p.m. produced severe mottled enamel; and more than 6 p.p.m. produced severe pitting and chipping. Deciduous teeth were affected by the higher concentrations. Waters containing 8–10 p.p.m. fluorine should not be used for cooking purposes. School children living in Salt River Valley showed high incidence of spotted enamel. Inhabitants using private water supplies showed greatest incidence. High-fluorine and low-fluorine waters were often found in same sections of valley. Low-fluorine waters were found in deepest wells. Chemical methods of fluorine removal from water are impracticable.—*R. E. Thompson.*

Lead Poisoning Caused by Drinking Water. A. Pellé and Artus. Bull. acad. méd., 113: 54 (1935). Lead is frequently found in drinking water of low mineral content. Covering interior of tubes with tin offers little protection because coating usually has rather high lead content itself. Numerous cases of poisoning have been reported.—*R. E. Thompson.*

Lead Content of the Water in Leipzig. Kruse. Z. Hyg. Infectionskrankh., 118: 143 (1936). Detailed analysis of water in Leipzig houses shows that lead content varies with season and acidity of water. Water in new houses showed highest content of lead.—*R. E. Thompson.*

Viability of Bacterium Coli and Bacterium Aerogenes in Water. A Method for the Rapid Enumeration of These Organisms. A. E. Platt. J. Hyg., 35: 437 (1935). Method employed consisted in planting each serial dilution of sample in duplicate in MacConkey's liquid medium. One portion was incubated at 37° and other at 45°. Presence of acid and gas at 45° indicated *E. coli*. If acid

and gas appeared at 37°, tube of Koser's citrate medium was inoculated. If growth appeared in latter medium, it was assumed that *A. aerogenes* group was present. In sterilized river water, *E. coli* survived longer than *A. aerogenes* at 0–2° and at 37°; at 18° both organisms survived same length of time. In raw water, both organisms died out at same rate at 0° and at 18° in light, while at 18° in dark and at 37°, *A. aerogenes* survived longer. In another test in which raw water flora was supplemented by addition of cultures of the organisms, *A. aerogenes* survived longer than *E. coli* at 18° and at 37°. At 0°, both survived equally well. Aeration of stored samples of water maintains viability of the bacteria and encourages their multiplication.—*R. E. Thompson.*

An Investigation of the Source of Arsenic in a Well Water. J. Wyllie. Can. Pub. Health J., 28: 128 (1937). Illness of occupants of farm, including one fatality, led to examination of the farm well water, which disclosed 0.4–10 p.p.m. of arsenic (as arsenious oxide). Well had been drilled to depth of 94 feet in limestone some 13 years before. Limestone from nearby had arsenic content (as arsenious oxide) of 15 p.p.m., probably present as ferrous arsenate. Large beds of arsenopyrite occur about 10 miles away. Although water was clear, filtration removed the arsenic and microscopic examination of filter discs disclosed brownish colored particles which chemical tests indicated to be ferrous arsenate. Scale from kitchen kettle was found to contain 4,000 p.p.m. arsenic (as arsenious oxide). Water from shallow neighboring wells was found to be free of arsenic. Clinical histories indicated that symptoms of chronic arsenic poisoning appeared after 2.5 years' use of well water.—*R. E. Thompson.*

The Survival of Various Intestinal Bacteria in Water. Henri Mouzet. Tech. sanit. munic., 31: 64 (1936). Shiga and Flexner tyes of dysentery bacteria, *Eberthella typhosus*, and *Salmonella paratyphi* and *scottmülleri* lived longest in either boiled water or in water filtered through bacteria-free filter and survived shortest time in untreated tap water. For example, *Eb. typhosus* died in tap water in 7 days, in distilled water in 11 days, and in boiled water in 30 days. It is suggested that these results show that chemically treated water is safer than boiled water and that if boiled water is used it should be drunk soon after boiling.—*R. E. Thompson.*

Possible Dangers to Health in Drinking Water from Reservoirs. Aug. F. Meyer. Chem.-Ztg., 60: 165 (1936). Industrial pollution in catchment area is more dangerous than domestic pollution. Wooded area is best. Peat moors are detrimental as they introduce humus, sulfur and acidity. They are sometimes isolated from the water by layer of calcium carbonate. Neutralization plants are expensive. Sediment deposited from such water should be periodically cleaned out. Streams feeding reservoir should be arranged for maximum aeration. Small reservoir in front of main one greatly helps bacterial purification. In Germany, use of filtration is general and while chlorination plants are provided they are only employed when necessary.—*R. E. Thompson.*

Relation Between the Occurrence of Endemic Goiter and the Presence of Traces of Silver and Barium in the Drinking Water. C. H. Boisevain and

W. F. Drea. Endocrinology, 20: 686 (1937). Traces of silver were found by spectrographic examination of drinking water from both goitrous and non-goitrous regions. Water from Swiss goiter region showed unusually large amount of barium. Feeding experiments, with rats, failed to show any influence of either silver or barium on development of goiter.—*R. E. Thompson.*

Solving Boron Problems in the Los Angeles Water Supply. R. F. Goudey. West Const. News, 11: 295 (1936). Boron content varied from 0.5 to 1.5 p.p.m. This is not considered harmful for drinking water, in which 30 p.p.m. is permissible, but it is considered objectionable for irrigation. Tendency is for boron to accumulate in certain lakes which are flushed into water supply by rains. This occurs chiefly in summer when irrigation is at peak. By means of storage basins, by-passing water of peak boron content and dilution with water from other sources, it is expected to reduce average boron content to less than 0.5 p.p.m. This is regarded as solving problem from standpoint of irrigation.—*R. E. Thompson.*

LABORATORY METHODS—CHEMICAL

Use of Activated Carbon for Determination of Nitrate, Nitrite and Ammonia in Water and Effluents. Georg Gad. Gas- u. Wasserfach, 79: 166 (1936). Activated carbon is useful in determining nitrogen in samples of colored water. Carbon must be carefully freed from ammonium salts by boiling with dilute aqueous sodium hydroxide. Tests described with such carbon on water containing nitrates and nitrites show that latter are fairly completely adsorbed in acid or neutral but not in alkaline solution. If, therefore, water is made alkaline and shaken with activated carbon the coloring matter is adsorbed and nitrogen content may then be determined in usual manner.—*R. E. Thompson.*

Estimation of Fluorine—Applications to Portuguese Mineral Waters. A. Herculano de Carvalho. Rev. quim. pura aplicada, 11: 99 (1936). Willard and Winter volatilization method modified by Boruff and Abbot for estimation of fluorine in mineral waters has incontestable advantages over other known methods. Colorimetric method of Sanchis gives comparable results and is even more convenient; exception is made of certain highly mineralized carbonate waters which require further study. Analysis of 33 Portuguese mineral spring waters reveals high fluorine contents (up to 22.8 milligrams per liter) in "nondegenerated" sulfur waters.—*R. E. Thompson.*

Rapid and Accurate Determination of Total Alkalies in Water. Roger Duroudier. Ann. fals., 29: 283 (1936). Method is described in detail based on elimination of alkaline earth bases by palmitate. Evaporate 100 cc. water to dryness on water bath, add few drops concentrated sulfuric acid, warm gently to complete evolution of SO_3, add a little finely ground ammonium carbonate and 2–3 cc. ethyl alcohol, ignite the alcohol and allow to burn without further heating, repeat twice, drive off ammonium sulfate below red heat and weigh sulfated residue; digest a few minutes on water bath with 20 cc. water, filter into 100-cc. flask, wash to about 80 cc., titrate to decided red in presence of phenolphthalein with potassium palmitate solution, warm on water bath

for about 15 minutes, cool, make up to volume, disintegrate some ashless filter paper in presence of small quantity of solution, spread pulp over coarse (No. 11E-I) Schott filter plate and filter solution under slight vacuum, pass liquid 2 or 3 times through same filter, compressing mat before each filtration, disintegrate fresh portion of ashless filter paper in small quantity of the opalescent filtrate and repeat filtering operation, filter through paper to eliminate last traces of fiber, and evaporate to dryness on water bath; impregnate with concentrated sulfuric acid, drive off SO_3 at low temperature, incinerate at low temperature over alcohol lamp to destroy slight excess of palmitic acid used in titration, take up once more in concentrated sulfuric acid and proceed as described above for determination of sulfated residue. Method gives results in excellent agreement with standard method and is particularly applicable when alkaline earths are determined by palmitate method.—*R. E. Thompson.*

New Method for Determining the Aggressiveness of Waters. R. Strohecker. Z. anal. Chem., 107: 321 (1936). Aggressiveness of water is calculated from pH value of water and its content of combined carbonic acid. If pH value obtained from equation, pH = 11.39 − 2 × log combined carbon dioxide, is greater than pH actually determined, water is aggressive: the greater the difference, the greater is the aggressiveness. With water whose CaO content is distinctly less than combined carbon dioxide value, e.g., with water which has no calcium sulfate hardness, equilibrium pH value with regard to lime content is obtained by equation, pH = 11.49 − log of combined carbon dioxide − log CaO. The pH values calculated by Tillman's method often do not agree with those determined experimentally. Reason is probably that constant K_1 of equation is not 3.07×10^{-7} but varies with increasing content of free or combined carbon dioxide.—*R. E. Thompson.*

Determination of Hardness in Water by Means of Soap Solutions. Halvard Liander. Iva 1936, 94–109. With pure calcium or barium salt solutions, Clark method (British patent 8875–1841) gives accurate and reliable results. Method can be used for magnesium salts if solution is prepared from soap of a saturated fatty acid, e.g., palmitic acid: with oleate results are inaccurate. It should be noted that soap solution must be standardized against salt of a metal with which it is to be used, since soap consumption for equivalent quantities of calcium, magnesium and barium is not the same. For given metal, identical results depend upon nature of anion, and within concentration range of about 0.5–12° dH the soap consumption is proportional to hardness. For mixtures of calcium and magnesium salts or for most natural waters method is less suitable. Factor which appears to affect results to considerable extent is choice of soap: it is advisable to use a soap of a saturated fatty acid under all conditions. Accuracy of Blacher method which is unquestionably more dependable for determining hardness of natural waters, can be increased by aid of comparison solution titrated to definite pH. Comparison solution should be very strongly buffered and contain one or more drops of emulsifying oil, which forms a pure white emulsion.—*R. E. Thompson.*

Determination of the Exchange Number of Zeolites by a Method Borrowed from Water Purification Practice and by a Quick Method. Egon Zentner.

Wärme, 59: 482 (1936). Quick method consists in shaking zeolite with sodium chloride followed by water of known hardness and determining residual hardness. Results are considered satisfactory for their purpose. Method is much more rapid than that which simulates water treatment practice.—*R. E. Thompson.*

Anhydrous Sodium Carbonate as a Standard of Reference in Acidimetry. G. FREDERICK SMITH AND G. F. CROAD. Ind. Eng. Chem., Anal. Ed., 9: 141 (1937). Anhydrous sodium carbonate dissociates to give off carbon dioxide when heated above 300°C. and becomes unfit for use as acidimetric standard, error being 3% after 4 hours heating at 390°C. Anhydrous sodium carbonate prepared by dissociation of sodium bicarbonate at 290–300° at 1 to 4 mm. pressure is suitable for acidimetric standard.—*Selma Gottlieb.*

Determination of Free Chlorine in Water by Means of Dimethyl-*p*-phenylenediamine. L. W. HAASE AND G. GAD. Z. anal. Chem., 107: 1 (1936). To prepare reagent, dissolve 1 gram pure dimethyl-*p*-phenylenediamine-hydrochloride in 100 cc. water, add 250 cc. 85% phosphoric acid while cooling and finally mix with filtered solution of iron-free disodium phosphate in 150 cc. water. Take 100 cc. water to be tested, add 0.4 cc. reagent, shake and immediately compare color with that of 0.00115% solution of methyl orange. Bibliography of 37 titles given and work of previous investigators discussed. By use of phosphoric acid, difficulties previously encountered with *o*-tolidine method are overcome.—*R. E. Thompson.*

A Modification in the Blacher Method of Determining Hardness of Water. E. GORDON BARBER. J. Soc. Chem. Ind., 55: 330 (1936). In determination of magnesium by titration with palmitate, presence of precipitated calcium oxalate interferes. By filtering the oxalate before titration a definite end point is obtained. Further improvement consists in omitting methyl orange in precipitating calcium oxalate and adding predetermined amount of acid. By means of these modifications more accurate results are obtained.—*R. E. Thompson.*

Simultaneous Estimation of Calcium and Magnesium by Potentiometric Titration: Application to Water Analysis. G. BEROZ AND C. CHRISTEN. Anales soc. cient. argentina, 7: 33 (1935). Natural water is neutralized, freed from carbon dioxide, treated with 25 cc. 0.1 normal sodium carbonate to precipitate calcium carbonate, and after 10 minutes with 15 cc. 0.1 normal sodium hydroxide to precipitate magnesium hydroxide; this is followed by heating 10 minutes on boiling water bath. The combined calcium and magnesium precipitates are filtered off and excess sodium carbonate and hydroxide determined potentiometrically.—*R. E. Thompson.*

The Determination of Fluorine in the Presence of a Large Excess of Aluminum Ions. DAN DAHLE AND H. J. WICHMANN. J. Assoc. Official Agr. Chem., 19: 320 (1936). Study of separation of small quantities of fluorine from large amounts of aluminum showed that for complete separation by distillation the usual procedure is not satisfactory. Distillation at higher temperatures or

collection of increased amounts of distillate is necessary. Effect on fluorine recovery of various pertinent factors was also studied and following method is suggested for isolation of fluorine occurring as impurity in aluminum sulfate and alums. Place aliquot of sample containing not over 0.8 gram aluminum in 125-cc. Claissen flask, add 20 cc. water and 15 cc. sulfuric acid, connect for a Willard and Winter distillation, mix, heat carefully to boiling, distil at 162 ± 2° and collect 300–350 cc. at this temperature; make alkaline to phenolphthalein, evaporate in porcelain casserole to about 50 cc.; cool, add 5 cc. 30% hydrogen peroxide, evaporate to about 5 cc., transfer to 125-cc. Claissen flask, add 7.5 cc. sulfuric acid and distil at 137 + 5°, collecting 100 cc. after temperature has reached 132°; make up to 150 cc. and determine fluorine by peroxidized titanium method on aliquot containing not more than 0.05 milligram fluorine. As little as 2 p.p.m. may be determined in this way; with smaller amounts or for greater accuracy, subject two or more portions each containing 0.8 gram aluminum to first distillation, combine distillates, evaporate and redistil.—*R. E. Thompson.*

A Quantitative Study of Fluorine Distillation. Dan Dahle and H. J. Wichmann. J. Assoc. Official Agr. Chem., **19**: 313 (1936). Various factors which influence recovery of fluorine by Willard and Winter distillation process were studied. Quantitative expressions are given to effects on recovery of such factors as (1) amount of nonvolatile acid used in distilling flask, (2) temperature at which distillation is carried out, (3) amount of distillate collected, (4) size of flask used and (5) presence of retarding influences such as aluminum salts and gelatinous silica. These data were applied to development of following rapid, semiquantitative test and to problem of increasing sensitivity of fluorine determination for very small quantities: distil fluorine-containing solution under known conditions of input volume and temperature and determine fluorine in first 10 cc. collected; amount found in these 10 cc. constitutes definite percentage of total amount present (40% if distillation is made at 125° with 10 cc. sulfuric acid and total input volume of 26 cc.). This allows approximate estimation of total without necessity of making complete distillation.—*R. E. Thompson.*

The Significance of Spectrum Analysis for Water Works. Karl Pfeilsticker. Gas- u. Wasserfach, **79**: 638 (1936). Spectrum analysis is a convenient means of tracing source of water and point of entrance of impurities, as mere traces of elements can be detected. Variations in chemical content of Neckar River are shown graphically and discussed, with reference to location of tanneries (variation in chromium content).—*R. E. Thompson.*

A Photometric Study of the Diphenylamine Reaction for the Determination of Small Amounts of Nitrate in Water. A. V. Trofimov. J. Applied Chem., (U. S. S. R.) **9**: 756 (1936). Most sensitive test for relatively small amounts of nitrate ions is obtained when solution containing about 73% sulfuric acid is treated with solution containing 10 milligrams of diphenylamine per liter of 89% sulfuric acid solution. Ratio of diphenylamine to nitrate should be about 100. This gives sensitivity of 5 milligrams of nitrogen per cubic meter, but sensitivity is changed if amount of nitrate is large. At concentrations used,

up to 1% chloride in solution increases color obtained but more than 10% decreases it. Large amounts of sulfates, 1% sodium bicarbonate and 3% mercuric chloride do not affect color. Latter can therefore be used as preservative. Higher temperature increases rate of formation and fading of blue color. Diphenylbenzidine can replace diphenylamine advantageously only in solutions containing very small amounts of nitrate. Since so many factors affect color, standards must be prepared under same conditions as test is performed.—*R. E. Thompson.*

New Method for Determining the Chlorine Value in Drinking Water and Sewage. H. IVEKOVIČ. Z. anal. Chem., 106: 176 (1936). Froboese's method for determining chlorine number gives too low results when water contains nitrogenous, oxidizable compounds. The error is overcome in following procedure: To 100 cc. of water in 200-cc. Erlenmeyer flask add 20 cc. 0.02 normal sodium hypochlorite solution and heat 30 minutes over boiling water. Cool 5 minutes under tap and add, from pipet, 10 cc. 0.05 normal sodium arsenite solution. Stir, add 1 drop methyl orange indicator solution and 10 per cent hydrochloric acid until permanent red color is obtained, making sure that any precipitated carbonate has dissolved by adding 2–3 drops of acid in excess. Add excess of sodium bicarbonate and, when it has dissolved, 1 cc. starch solution. Titrate excess aresnite with 0.02 normal iodine. Ratio of chlorine number to potassium permanganate consumed is affected by presence of nitrogenous, oxidizable organic and inorganic compounds. Values for chlorine and of potassium permanganate consumed have little significance except in connection with other analytical data.—*R. E. Thompson.*

Determination of Phosphates in Turbid and Colored Natural Waters. S. V. BRUEVICH AND E. I. PLETNIKOVA. J. Applied Chem. (U. S. S. R.) 9: 925 (1936). Turbidity, color and humic substances interfere with colorimetric determination of phosphate by ceruleomolybdic method. Suspended matter should be removed by ultrafiltration. Nearly complete decolorization with elimination of coloring colloids, but without affecting true phosphate content, may be effected by adding 1 cc. 8% sulfuric acid and 1 cc. 10% barium chloride to 200 cc. of the water, hot or cold, and letting stand 2–12 hours. Effect of residual yellow color may be overcome by use of compensating color scale. Treating turbid natural waters with sulfuric acid, as in coagulation with barium chloride or other agents, without preliminary ultrafiltration, results in considerably increased phosphate content, due to solution of phosphate contained in suspended matter. In complete analysis, phosphate in solution and in suspended matter should be determined.—*R. E. Thompson.*

Determination of Lead in Potable Waters. SIDNEY L. TOMPSETT. Analyst, 61: 591 (1936). Take water in sufficient quantity to obtain 0.05–0.10 milligram of lead. Evaporate to small volume in Pyrex flask and mix with 1 cc. concentrated sulfuric acid and 1 cc. perchloric acid. Continue heating until organic matter is destroyed, cool and treat with reagents in following order: 1 cc. water, 1 cc. glacial acetic acid, 5 cc. 20% sodium citrate solution and 5 cc. concentrated ammonium hydroxide. Dilute to 25 cc. Meanwhile prepare

blank by mixing acids, heating till all perchloric acid is expelled, cooling and adding above quantities of acetic acid, citrate and ammonia. In one of three flasks place 5–10 cc. of blank, in second 5 cc. of treated sample and in third a solution containing 0.01–0.02 milligrams of lead. To each flask add 6 drops 5% sulfuric acid, 5 cc. 10% potassium cyanide solution, 10 cc. carbon tetrachloride and 0.5 cc. 0.1% diphenylthiocarbazone solution. Shake vigorously. Remove aqueous solution from carbon tetrachloride solution that contains lead complex and some excess reagent. Shake with potassium cyanide solution to transfer excess reagent to aqueous layer, continuing this treatment until colorless aqueous layer is obtained and then compare standard and unknown in colorimeter. If much iron is present, preliminary separation of lead is advisable. To accomplish this, treat sample with diethyldithiocarbamate at pH above 7.5 in presence of sodium pyrophosphate or at pH above 9 in presence of sodium citrate. Good results were obtained with samples containing 0.02–0.75 milligram lead.—*R. E. Thompson.*

A Comparison of Routine Methods of Determining Hardness of Water. G. W. Bond. J. S. African Chem. Inst., 19: 50 (1936). Samples of various composition were analyzed for hardness by palmitate, soap and Hehner methods. Comparative results, tabulated in detail, lead to following conclusions: (1) With soap method, fairly accurate results for total hardness can be obtained except on waters with high magnesium and chloride contents; data on temporary and permanent hardnesses are totally misleading. (2) Conventional Hehner method fails on water containing appreciable chloride and magnesium. (3) Combination of Hehner and soap methods gives fair approximations except on water high in magnesium and chloride (*i.e.*, determination of total hardness with soap solution and temporary hardness by Hehner method). (4) Palmitate method gives results on all samples in close agreement with figures for total, temporary and permanent hardness obtained by calculation from gravimetric data, except on water high in magnesium chloride. Total hardness due to magnesium and calcium salts by this method agrees with calculated values. Recommends wider use of palmitate method.—*R. E. Thompson.*

Oxidation with Potassium Permanganate. A. J. J. Van de Velde. Natuurw Tijdschr., 18: 191 (1936). Results of oxidation with potassium permanganate in presence of sulfuric acid are subject to wide variations according to nature and concentration of compounds present, concentration of oxidant and time. Determination of organic matter in water by this method is therefore very uncertain even for comparative purposes. It cannot be used at all with waste waters, *e.g.*, distillery wastes, and with drinking water only by using 0.01 normal solution and heating on boiling-water bath for not longer than 30 minutes.—*R. E. Thompson.*

Alkaline Phosphate Method for the Determination of the Hardness of Natural Water. S. Drachev and T. Karel'skaya. J. Applied Chem., (U. S. S. R.) 9: 1499 (1936). Titrate 50 cc. of sample with 0.05 normal hydrochloric acid using methyl orange as indicator and removing carbon dioxide by blowing air through solution until pink color obtained remains unchanged. Treat with

sufficient calcium chloride to increase hardness by 25 German degrees and with 10 cc. alkaline phosphate solution (100 cc. 4% $Na_2HPO_4 \cdot 7H_2O$ and 110 cc. 0.1 normal sodium hydroxide), let stand 30–40 minutes, warm to 40–50° and filter. Titrate a 50-cc. aliquot as above. Hardness in German degrees is calculated from $X = [(A - 2B)K \times 2.1 \times 2] - 25°$, where A is volume in cc. of 0.05 normal hydrochloric acid used for titration of 10 cc. of alkaline phosphate solution, B that for titration of residual alkali, 2.1 is coefficient converting results to German degrees and K is correction coefficient for solution. If initial hardness of water is 30 German degrees it is not necessary to add calcium chloride and if it is over 60 alkaline phosphate added must be increased to 20 cc. Sensitivity of method is 0.1–0.2 German degree and accuracy 0.3–0.4 degree. Errors may be introduced by (1) poor precipitation of magnesium phosphate, yielding finely dispersed precipitate that passes through filter paper, and (2) influence of carbon dioxide upon completeness of precipitation and upon accuracy of neutralization before precipitation.—*R. E. Thompson.*

Microdetermination of Chlorine. I. M. KORENMAN. Mikrochemie, 19: 144 (1936). Winkler determined active chlorine in water by decoloration of methyl red solution (0.1 gram in 1 liter of water; 1 cc. = 0.05 milligram chlorine). Results do not agree with those obtained by microiodometric method unless methyl red solution is standardized against solution containing known quantity of active chlorine. Decolorization is slow toward the last. In determining 0.04–7.9 milligrams chlorine per liter, results obtained on substitution of methyl orange for methyl red agreed within less than 4 per cent with values obtained by microiodometric method but here again it is necessary to standardize methyl orange solution (0.33 gram per liter) against solution of known chlorine content.—*R. E. Thompson.*

BOILER FEED WATER

Modifications of the Hot Process when Conditioning Make-up for High Pressure Boilers. C. JOOS. Combustion, 8: 4; 32 (1936). Explains the variations from the convential lime-soda treatment which are frequently used with hot-process softeners for conditioning boiler feed water, particularly for high pressure boilers. The reactions involved in lime-soda treatment supplemented by phosphate, caustic soda treatment, lime-gypsum treatment with supplementary phosphate treatment, sulphuric acid and lime with supplementary phosphate treatment, softening with phosphates and two-stage softening are described. Lime-soda treatment has the advantage of reducing the silica and organic matter in the water by about 60 per cent. The use of lime and soda alone is not recommended for boiler pressures exceeding 250 lb. per sq. in.; supplementary treatment with phosphate is desirable. The phosphate prevents the formation of silica scale, enables a low boiler water alkalinity to be maintained, facilitates the maintenance of sulphate ratios in accordance with the A. S. M. E. Code, and precipitates any residual hardness; mono-sodium or meta-phosphate are generally used. Caustic soda treatment can be applied only to water in which the permanent hardness in the form of calcium sulphate is sufficient to consume most of the soda ash produced by the reaction with the carbonates. Since such a balance is not generally encoun-

tered in water supplies and the relation of carbonates to permanent hardness in surface streams varies from time to time, lime-soda treatment is preferable. Caustic soda can however be used with lime when carbonates predominate or with soda ash when the permanent hardness is high but the results are the same as with lime-soda treatment and an extra chemical is used. Well waters containing large amounts of sodium carbonate and silica and little sulphate can be satisfactorily treated with lime and gypsum supplemented by phosphate to prevent formation of siliceous scales. Sulphuric acid may be used instead of the gypsum for waters containing much sodium carbonate. Softening with tri- or di-sodium phosphate in conjunction with soda ash is applicable to water with a hardness not exceeding 3 gr. per gal. and is particularly suitable for soft turbid waters where coagulation and softening can be effected in a single apparatus. Sufficient phosphate should be added to provide an excess of about 5 p.p.m. as trisodium phosphate and to maintain a pH value exceeding 8.5. With raw water supplies the trisodium phosphate is used with caustic soda which maintains the desired pH values. These reagents produce an effluent with a high pH value and containing little oxygen or hardness. Two-stage softening has been developed for treating waters containing much carbonate. The water is first treated with lime and soda ash either cold or hot and then with phosphate, generally disodium phosphate, in a hot-process softener.—*W. P. R.*

Foaming and Priming of Boiler Water and Condenser Leakage. Electrometric Method of Measurement. Richard Ulmer. Ind. Eng. Chem., 9: 172 (1937). Samples of distilled water and contaminated condensate are placed in twin cells containing identical Monel or nickel electrodes. Contaminating solution (boiler water or cooling water) is added to distilled water side from burette until electrical conductances are equal as indicated by voltmeter readings. From volume of contaminating solution required, concentration in condensate can be determined. Method has greatest sensitivity at low concentrations where chemical methods fail.—*Selma Gottlieb.*

New Developments in the Treatment of Feed Water. Charles E. Joos. Power Plant Eng., 40: 638 (1936). Special attention is given to a deaerating hot process softener, use of sodium sulfite for fixation of oxygen and external softening and conditioning with phosphate.—*R. E. Thompson.*

Feed-Water Treatment for Modern Steam Generators. Charles E. Joos. Power plant Eng., 40: 582 (1936). Treatment of feed water must be decided for each plant and each water; corrosion, embrittlement, carry-over and scale must be considered. The various external methods of treatment, evaporation, hot-process lime-soda and zeolite, are considered. Several examples are given showing where these different processes are effective and where they are not, together with general data as to modern equipment for zeolite softening. It is felt that evaporators are not generally well suited, largely as result of high individual investment and high operating cost.—*R. E. Thompson.*

Treat Feed Water to Prevent Carryover. S. E. Tray. Power, 80: 365 (1936). Measurement of electrical conductance of condensed steam, which is propor-

tional to dissolved solids in solution (from carryover), is recommended. Use of iron "products," finely dispersed in water, has been found effective in controlling boiler water treatment.—*R. E. Thompson.*

Effect of Solution Composition on the Failure of Boiler Steel under Static Stress at 250°C. W. C. Schroeder, A. A. Berk and E. P. Partridge. A. S. T. M. Proc., 36: II, 721 (1936). Experiments described showing that c.p. sodium hydroxide has little effect on tensile load which a steel specimen will carry unless specimen has a line of stress concentration. The lowest concentration of sodium hydroxide required to cause failure of eccentric grooved specimens in sodium silicate—sodium hydroxide depends to a considerable extent on applied load. Marked effects of sodium silicate and the influence of sodium sulfate, sodium nitrate, sodium chromate, trisodium phosphate, sodium sulfite and potassium permanganate are shown under certain conditions. Sodium sulfite is reduced by iron and hydrogen at 250°C.—*T. E. Larson.*

Boiler Water Treating by Means of the "Dejektor." Züblin. Feuerungstech., 24: 159 (1936). Raw water and treating agents are added directly to boiler and water from bottom of boiler is circulated continuously by means of thermosiphon effect through external settler in which sludge accumulates and is drawn off from time to time.—*R. E. Thompson.*

The Vaporization of Boiler Salts. A. Kleinhans. Arch. Wärmewirt., 17: 127 (1936). Using gas laws and Raoult's law, author calculates that vapor pressure of salts found in boiler water is negligible under boiler conditions. Salts in steam come from entrainment.—*R. E. Thompson.*

Do Neutral Salts Ever Fail to Concentrate in a Boiler? Karl Hofer. Arch. Wärmewirt., 16: 289 (1935). It has been reported that when trisodium phosphate is used to soften boiler water and blowdown is returned to softening system, expected building up of neutral salts does not occur. This is not due to action of precipitate on water. A sulfate and chloride balance on carefully controlled system indicated that enrichment proceeds until it is counterbalanced by losses through leaks, entrainment in steam, etc.—*R. E. Thompson.*

Determination of Dissolved Oxygen in Boiler Feed Water. A. H. White, C. H. Leland and D. W. Button. A. S. T. M. Proc., 36: II, 697 (1936). Progress report covering work being carried out at the University of Michigan under auspices of Subcommittee VIII on Standardization of Water Analysis Methods of the Joint Research Committee on Boiler Feed Water Studies. Brief review given of errors in the Winkler procedure for the determination of less than 0.10 ml. dissolved oxygen per liter. Using a 1-liter sample, the distillation procedure, and electrometric titration for the end-point, the over-all error should not be over .002 ml. oxygen per liter.—*T. E. Larson.*

Analytical Determinations Necessary to Control the Softening of Boiler Feed Water with Trisodium Phosphate. Kurt Hoppner. Deut. Zuckerind., 61: 132 (1936). For maintenance of optimum alkalinity in boilers it is necessary

to determine the sodium factor, $\frac{\text{mg. } Na_2CO_3 \text{ per l.}}{4.5}$ + NaOH (mg. pe l.), which should be 400–600 in boilers with 20 atmospheres pressure. Regular examination of water in boilers should include phenolphthalein and methyl orange alkalinities (from which are calculated total, sodium hydroxide, sodium carbonate and sodium bicarbonate alkalinities), hardness, excess phosphate and total salt content.—*R. E. Thompson.*

Symposium on Feedwater Heating. R. M. Osterman, R. K. Smith and L. F. Wilson. Railway Age, 101: 866 (1936). Osterman recommends closed type heater with use of tannin bricks to prevent incrustation on tubes to effect net fuel saving from heated feed water in locomotive operation. Smith calls attention to advisability of checking operating performance against rating. Wilson recommends open-type heater to obtain benefit of reduction in dissolved oxygen and a centrifugal pump operation with heated water storage.—*R. C. Bardwell.*

Use of Phosphates in Water Treatment. J. J. Laudig et al. Am. R. Eng. Assn. 38. Bulletin 389, 97 (1936). The use of phosphates for prevention of scale in steam boilers is definitely recorded as early as 1886. Figures are given comparing efficiency and economy for eight different types of commercially available sodium phosphates.—*R. C. Bardwell.*

Water Treatment for the Small Boiler Plant. Matthews, F. J. Colliery Eng., 14: 52 (1937). A general consideration of the internal treatment of boiler water. The reactions occurring when a scale-preventing compound incorporating sodium hydroxide is used and three possible methods of procedure are outlined. The action of colloids in preventing scale formation is described. Colloids available for use with alkaline salts include tannins, cambier, galls, campeche wood, quebracho, cutches, and substances such as dextrin. Sufficient colloid should be used to leave a slight excess in the boiler water. Less than the theoretical amount of alkali salts can be used. The optimum treatment is best determined by trial. Internal treatment leads to accumulation of sludge which is liable to cause priming and wet steam but may be satisfactorily controlled by systematic blowdown. The time of steaming necessary to produce a maximum concentration of total solids in the boiler water suitable for efficient operation of the unit can be readily calculated, thus allowing the intervals between blowing down and the amounts of blowing-down to be specified; formulae are given. The successful use of a paste mixture of about 60% caustic soda and 40% disodium phosphate, concentrated in tannin extract until the final preparation contained about 30-35% tannin extract, in removing sludge and scale is mentioned. The sludge and scale were formed as the result of a lime-soda softening plant delivering incompletely softened water to the boilers. The mixture was added to the softening tanks after addition of the regular softening chemicals.—*W. P. R.*

Treatment of Silica for High Pressure Boilers. S. E. Tray. Power Plant Eng., 40: 515 (1936). Describes methods for the control and prevention of

silica scale in high pressure boilers. Silica deposits are usually thin but have a lower rate of heat transfer than another type of scale. Two types of silica scale are found in boilers, a normal calcium silicate scale and a double silicate of sodium and aluminum called analcite. Lime-soda and zeolite softening do not remove silica. Addition of magnesium salts and zinc, iron and aluminum sulphates to the feed water have been tried but with little success. Internal treatment has been more successful. Silica may be kept in solution or precipitated as sludge. The addition of sodium phosphate removes calcium and magnesium hardness and so keeps the silica in solution. A pH value of 11.5 or higher is however necessary and this may lead to increased priming. Further there is a tendency for analcite to be formed in the presence of alumina. Silica may be removed as sludge in the boiler by the addition of iron compounds. At a pH value of 10.5 complete precipitation of silica occurs. The sludge is removed from the boiler by blowing down. When silica has been removed it is found that the usual softening agents are more effective in preventing carbonate and sulphate scale formation.—*W. P. R.*

A Study of the Reactions of Various Inorganic and Organic Salts in Preventing Scale in Steam Boilers. FREDERICK G. STRAUB. Univ. Ill. Eng. Expt. Sta., Bull. 283 (1936). Studies were carried out employing apparatus developed in earlier work. Studies of siliceous scales showed that calcium carbonate, calcium fluoride and tricalcium phosphate when present as solids do not react to reduce silica content of alkaline sodium silicate solutions containing 200 p.p.m. silica. Presence of solid calcium sulfate, however, reduced silica to 12 p.p.m. Under same conditions, magnesium oxide and magnesium carbonate bring silica down to 6 p.p.m. In presence of sodium aluminate and sodium hydroxide, magnesium oxide reduces silica to 3 p.p.m. Analcite, $Na_2O \cdot Al_2O_3 \cdot 4SiO_2 \cdot 2H_2O$, a typical siliceous scale found in boilers, was synthesized and found to increase in solubility with temperature and alkalinity, but solubilities of silica and alumina are not in same ratio as when combined in this complex silicate. Formation of calcium sulfate scale is prevented by presence of 50 p.p.m. sodium fluoride in solution at temperatures up to 470°F., even with sodium sulfate concentrations up to 2000 p.p.m. Work with organic substances showed in general that in the experimental boiler at steam pressures between 250 and 900 pounds per square inch, pyrogallol, gallic acid and similar compounds were effective in preventing calcium sulfate, silicate and sodium aluminum silicate scaling, the first particularly when alkalinity was low.—*R. E. Thompson.*

The Use of Solubility Data to Control the Deposition of Sodium Sulfate or its Complex Salts in Boiler Waters. W. C. SCHROEDER, A. A. BERK AND E. P. PARTRIDGE. A. S. T. M. Proc., 36: II; 755 (1936). Data given for the solubility of sodium sulfate in sodium hydroxide solutions of various concentrations in the presence of sodium chloride, sodium carbonate, or trisodium phosphate. The solubility curves are not recommended for direct calculation of sulfate to hydroxide ratios for embrittlement protection unless certain assumptions are made concerning the lowest concentrations of sodium hydroxide which will attack the steel. Further work is being carried out to determine these limiting values.—*T. E. Larson.*

Present Status of Feed Water Treatment for Boiler Operation. R. STUMPER. Rev. tech. Luxembourgeoise, 28: 63 (1936). Elimination of impurities tending to form scale, cause corrosion or humidify the steam produced is discussed. Permissible maximum content of oxygen for boilers working under high stress is 0.1 milligram per liter up to 30 atmospheres, 0.05 up to 70 atmospheres and 0.02 above 70 atmospheres. Phosphate content for such boilers should not exceed 10–30 milligrams (as P_2O_5) per liter. Prevention of caustic embrittlement depends on maintenance of definite ratio of sodium carbonate to sodium sulfate, which should be 1:1.1 for pressure of 10 atmospheres, 1:2.3 for 20 atmospheres, 1:3.3 for 30, 1:40 for 40, 1:4.4 for 50, 1:4.8 for 60 and 1:5.0 for 70.—*R. E. Thompson.*

CEMENT AND CONCRETE

Portland Cement. Effects of Catalysis and Dispersion. H. L. KENNEDY. Ind. Eng. Chem., 28: 8, 963–9 (1936). Mixture of triethanolamine salts and highly purified soluble calcium salts of modified lignin sulfonic acids, called new TDA, was studied as dispersing agent for cement. When added to clinker, it aids grinding and permits manufacture of high early strength cements by fine grinding of most standard clinkers containing 45% or more of tricalcium silicate, without double burning or other expensive additional operations. It may also be used to make cements of exceptional workability and very low bleeding tendency when high early strength is not required. For given mixture, strength at all ages is increased by treatment with TDA. Concretes made with TDA cement are much more resistant to freezing and thawing than are untreated. Workability is high, and product shows decreased bleeding, decreased permeability to passage of water, and less loss of strength on warehousing due to formation of lumps. Grinding rates are increased with TDA. TDA shows practically no tendency to increase amount of air entrained in interstices of cement, unlike product originally used which increased entrained air about 0.7% by volume.—*Selma Gottlieb.*

Tight Form Joints Stop Cement Leakage. ANON. Eng. News-Rec., 117: 371 (1936). It has been noted in concreting of Colorado River aqueduct of Metropolitan Water District of Southern California that surprisingly small cracks in forms are sufficient to cause leakage of cement, leaving gravel pocket in surface of concrete rough enough to require patching. This is especially true when vibrators are employed. Leakage is most likely to occur at joints between invert and inside arch form and in joints in arch forms on curves where insertion of gores is necessary. Former is avoided by setting arch forms on strip of sponge rubber on poured invert and latter by sealing forms with 2-inch friction tape.—*R. E. Thompson.*

Heated Air Space Eliminates Frost Destruction in Tank Walls. L. A. MARSHALL AND H. M. WHITMORE. Eng. News-Rec., 118: 294 (1937). When Division Ave. filter plant in Cleveland was constructed in 1916, design did not call for pile foundations although site was in region of peat and quicksand overlying bed of stiff clay. As consequence, structural failures of various kinds

soon developed and kept recurring due to soil movement and settlement. Completion of present work is expected to mark termination of 20-year period of reconstruction which to date is estimated to have cost over $1,000,000. Plant, occupying area of about 34 acres, includes pumping station, filter building and 20,000,000-gallon covered reservoir. Raw water is taken from Lake Erie and pumped through 72-inch pipe line to mixing basins, settling basins and 36 filters housed in building 750 feet long and arranged in 2 rows of 18 each. North wall of building, upper part being northerly enclosure of 18 filters and lower part enclosing base on which filters are supported, is an exposed face extending 23 feet above ground and continuous seepage from filters has occurred due to structural weaknesses, porous concrete and laitance-filled joints. As result, frost action in winter caused serious disintegration of concrete wall. Attempts at waterproofing and repair were abandoned as impracticable and program finally adopted consists of removing unsound concrete and replacement with non-shrink, integral-waterproofed concrete, coating of wall inside and out with air-applied concrete plaster, 1 inch thick, and construction of new brick and hollow-tile wall, 12 inches thick, parallel to and 43 inches from outside of old wall. Space between is closed at top with concrete slab and temperature therein is kept above freezing point by circulating heated air by means of unit heaters and electric fans, temperature being automatically controlled by thermostats. New wall was built in 2 sections: west half, completed last year, has passed through all seasonal changes and results have been highly satisfactory. Other reconstruction work has included relining of reservoir, underpinning of effluent galleries and part of filter building, sheet piling around 3 sides of filter building to check ground movement, extensive repairs to settling basins and reinforcing and waterproofing of decks of 18 north filters. —*R. E. Thompson.*

Curing Rooms and Cold Tests for Better Concrete. V. L. GLOVER. Eng. News-Rec., 117: 893 (1936). Details are given of the freezing and thawing and curing room equipment of the new materials lab. of the Illinois Division of Highways. The design of the curing room is based upon the assumption that the mixing water present in fresh concrete is sufficient to produce chem. combination of the ingredients of the cement provided this water can be held intact. The equipment provides for accurate temp. control and a high relative humidity.—*R. E. Thompson.*

Handling of Concrete and Aggregates. LEWIS H. TUTHILL. Eng. News-Rec., 117: 934 (1936). Schematic presentation of principles which must be followed in order to avoid segregation. Sketches prepared to accompany specifications of Metropolitan Water District of Southern California.—*R. E. Thompson.*

Deterioration of Concrete Owing to Chemical Attack. F. M. LEA. Surveyor, 89: 669 (1936). Aluminous cement concrete, properly made, is immune to attack by sulfates. Soils high in sulfates may attack portland cement concrete. Saturated solutions of sodium, magnesium and calcium sulfates found in soils have been shown to be destructive.—*R. E. Thompson.*

FLOODS

Ohio River's Worst Flood Cuts Railroads in Two. ANON. Railway Age 102: 214 (1937). The most devastating flood in its history swept down the Ohio River and its tributaries from January 15 to 30, inundating and damaging railroad property and interrupting service at all major points from Pittsburgh, Pa. to Cairo, Ill. Not only was the property of the railroads which follow the course of the river flooded, but the service of lines operating between the north and south was also inoperative for several days due to river crossings and approaches being under water. The greatest damage to railroad property was experienced at Cincinnati.—*R. C. Bardwell.*

Service Restored Rapidly as Ohio Recedes. ANON. Ry. Age. 102: 248 (1937). With the receding of the crest of the worst flood ever experienced in the Ohio River, restoration was started and trains were again operating into most of the flooded area by Feb. 6. As highways were also flooded and damaged, in many cases the railroads were the chief source of transportation for supplies and the returning refugees. As most of the city water plants in this territory, including as examples, Cincinnati, Ohio, Louisville, Ky., and Huntington, W. Va., were inundated and badly damaged, as well as many of the water stations owned and operated by the railroads, unusual efforts were required to provide the necessary water supply for the locomotive boilers without which operation could not be started. In addition to cooperating closely with the local civic and Red Cross officials, the railroads assisted in providing quarters for the refugees, where possible, and also hauled approved drinking water for several days to some of the small towns where entire local supplies had been lost or contaminated.—*R. C. Bardwell.*

Rehabilitation of the Ohio Valley. H. W. RICHARDSON. Eng. News-Rec., 118: 380 (1937). Rapid progress is being made in repairing damage caused by flood. Health situation throughout has been excellent. At Paducah, river rose above flood stage (43 feet) on January 17 and did not return to banks until February 21. Peak stage was 60.8 feet and water remained within 1 foot of that level for 10 days. Previous record was 54.3 in 1913. Some 7.5 of city's 8.5 square miles was inundated and 90% of buildings and 95% of population were affected. Pure water was restored on February 22 but water for sanitary purposes was available in mains several days earlier. Louisville suffered greatest total loss. Peak stage was 57.4 (upper gage) compared with previous record of 46.7 in 1884. Waters of river surged 12 feet over top of Portsmouth's river wall. Sewer valves were opened to flood city gradually but river rose so fast that wall was topped long before backwaters had built up much of a head. Top of wall is 62 feet on local gage. High stage was 74.2: in 1913, stage was 67.9. Water pumping station failed, but reservoir supply, doled out for few minutes each day, lasted through the emergency.—*R. E. Thompson.*

Control of Great Floods. ARTHUR E. MORGAN. Eng. News-Rec., 118: 401 (1937). Discussion of general conditions for developing and administering river control plan. Comprehensive and well integrated plans for national flood control represent essential economy in national life. Fundamental

requirements include completely new and fresh analyses of old situations, on assumption that old conclusions may no longer be valid, and habit of thinking and working in far larger dimensions than heretofore. Policy of rigorous adherence to thorough examination of every possible method of solution must be adopted. Only rarely in any large project will solution be found to consist of any single type of construction. The procuring of basic data is of vital importance. Flood control must be viewed as part of program for integrated river control for all purposes and interrelations of tributary systems should be coordinated so that plan and program shall emerge for the most inclusive river system.—*R. E. Thompson.*

Flood Plan Drafted for New England. ANON. Eng. News-Rec., **118:** 533 (1937). Four-state compact between Connecticut, Massachusetts, Vermont and New Hampshire for flood control on Connecticut River has been drawn up by subcommittee named by the several governors and now awaits action by legislatures of states involved. Initial construction of 8 reservoirs at estimated cost of about $12,700,000 is provided for, of which amount Federal Government would provide about $10,000,000. Compact sets up Connecticut River valley flood control committee with 3 salaried members from each state, provides for setting up of an organization, and gives the board wide powers with respect to operation. Proposed 8-reservoir plan is part of long-range program which would ultimately involve construction of 20 reservoirs at cost of nearly $55,000,000. To become effective, compact must be approved by state legislatures and by Congress.—*R. E. Thompson.*

DAMS

Arch Dam of Ice Stops Slide. GRANT GORDON. Eng. News-Rec., **118:** 211 (1937). Grand Coulee Dam rests on foundation of solid granite of exceptionally fine quality directly above which is glacial silt of ultra-fine rock flour containing 20–25% colloidal material. Undisturbed and in its original horizontal bedding, material will stand indefinitely in vertical face of moderate height, but once disturbed it is unstable in slopes steeper than 1 on 4, even when comparatively dry. When moistened and disturbed, material takes on consistency of axle grease; when dry and pulverized it forms an impalpably fine dust. Various methods, drainage, removal of surcharge and adding weight to toe, have been used to combat slides in this material. Combination of conditions led to adoption of frozen arch to stop major slide on east forebay. Freezing method of F. H. Poetsch of Prussia, used in sinking deep shafts, is nearest approach to similar undertaking. Ammonia-brine refrigeration system was selected and 377 freezing points spaced 30 inches center to center both ways and driven to average depth of 43 feet were used. Arch was 100 feet long, 20 feet thick and 40 feet high, cubic yards of material frozen being about 3,000. Cost was $30,000, or $10 per cubic yard.—*R. E. Thompson.*

Hodges Dam Strengthened. FRED D. PYLE. Eng. News-Rec., **117:** 644 (1936). How to strengthen and increase rigidity of Hodges Dam, a very light concrete multiple-arch structure that lacked adequate transverse bracing and whose buttresses were cracked, has been problem confronting City of San

Diego for years. Cracks which appeared in each of higher buttresses not long after completion of dam were found by measurements between bronze spuds grouted into concrete to be steadily increasing in width. Comprehensive studies were made, various alterations in design were considered, and finally contract was awarded early this year. Dam, which is important unit of water supply system, was constructed by San Diequito Mutual Water Company on San Diequito River in region of known seismic activity in 1917-8. Top of dam is 130 feet above stream bed and maximum height above lowest foundation is 136 feet. Crest length is 616 feet and reservoir capacity at spillway level 37,700 acre-feet. City acquired system in 1925 by lease with option to purchase, total price being $3,750,000, of which city still owes about $3,000,000. Thus there is joint interest in any reconstruction beyond repairs incidental to ordinary maintenance. Details of repair procedure are given, design finally selected being an approach to the twin buttress type. Total estimated cost of repairs is about $150,000.—*R. E. Thompson.*

Black Warrior River Dam, Birmingham. ANON. Eng. News-Rec., 117: 701 (1936). Alternative bids on impounding dam, 1500 feet long by 185 feet high, on Black Warrior River 40 miles above Birmingham, Alabama, reflect 7.75% saving for rockfill compared with concrete structure. Three bidders, however, were 5–25% higher for rock dam than for concrete. Work is part of city's new industrial water system. Unit prices from 3 low bids given.—*R. E. Thompson.*

Boca Dam, Truckee River. ANON. Eng. News-Rec., 117: 701 (1936). Unit prices given from 3 lowest bids on construction of earth dam across Little Truckee River, 20 miles southwest of Reno, Nevada. Dam will be 1650 feet long and 110 feet high at crest, made up of moistened and rolled embankment of clay, sand, and gravel, with downstream slope covered with heavy rock fill and upstream slope with 3 feet of riprap.—*R. E. Thompson.*

Dam Building Reaches a Climax. ROBERT A. SUTHERLAND. Eng. News-Rec., 117: 807 (1936). Completion of dams of unprecedented dimensions raises question of whether present decade will not in future be looked upon as climax, or at least a definite peak, in era of dam building that began in middle of nineteenth century. Developments which marked various stages of era are reviewed and tabulation presented showing principal characteristics (location, type, height, length, volume, year completed, and acre-feet of storage provided) of more than 600 dams over 100 feet high, completed, under construction, and projected. These data are then summarized tabulary and graphically to show trends in regard to type, height, and volume by decades. Latter shows overwhelming predominance of gravity dam (49% of total number), this predominance being more marked in the greater heights. In decade 1920–30, over 200 important dams over 100 feet in height were built in various parts of world and almost as many have been completed or commenced within present decade. Since about 1900, number of existing dams over 100 feet high has practically doubled every 10 years.—*R. E. Thompson.*

Progress at Imperial Dam. ANON. Eng. News-Rec., 118: 92 (1937). Construction is proceeding from both sides of Columbia River. Diversion will probably be effected early this summer to enable mid-channel portion to be completed. Work on desilting plant has progressed to point where installation of silt-gathering mechanism is under way. Plans provide for removal of all heavy sediment from constant flow of 15,155 second-feet, full capacity of All-American Canal. Well points are being employed to unusual extent in foundation work.—*R. E. Thompson.*

Practical Soil Mechanics for Small Dams. DENZIL DOGGETT. ANON. Eng. News-Rec., 118: 409 (1937). Practice evolved by Indiana Dept. of Conservation in building some 30 small earth dams since 1928 is outlined, together with brief account of character and purpose of these water conservation projects. Practice includes drop-inlet spillway designed for characteristics of each dam site, selection of materials on basis of screen analyses, use of impervious clay for upstream third of dam and in cut-off trench and selected materials, not necessarily impervious, for downstream two-thirds, and control of compaction by methods evolved by R. R. Proctor.—*R. E. Thompson.*

Conchas Dam and Reservoir Project. JOHN R. NOYES. Eng. News-Rec., 118: 541 (1937). Details are given of early work and basis of design of project to regulate and utilize flood waters of South Canadian River, tributary of Arkansas River, at cost of $12,280,000. Site chosen is short distance below mouth of Conchas River, important western tributary. Main dam, 1250 feet long and 235 feet high, will be concrete gravity structure. In addition, 13,650 feet of wing dams and dikes, composed of earth embankments, will be required, exclusive of 3000-foot emergency spillway, which will be a concrete overfall weir. Earth dikes will reach maximum height of nearly 90 feet and will consist of impervious rolled-earth core, pervious rolled blanket and rock-fill shells on upstream and downstream slopes. Water supply for domestic (camp) and construction purposes was serious problem. Suitable ground water being unavailable, it was necessary to develop supply from river, water of which is hard and heavily silt-laden. Temporary sheet-pile and rockfill detention dam creates pool about 3 miles long on South Canadian River just above mouth of Conchas, from which water is pumped to treatment plant at camp through 8-inch spiral-welded steel pipe line 14,140 feet long. Treatment consists of chlorination, addition of alum and activated carbon, and settlement. Provision was made for storage of 10 million gallons in tanks to guard against shortage.—*R. E. Thompson.*

Hydraulic Models Used in Design of Parker Dam. S. PERLITER. Civ. Eng., 7: 409 (1937). Hydraulic models were called upon to answer such questions as: (1) The proper shape of the overflow crest, (2) the most favorable location of the power plant, (3) the most desirable operating conditions of the gates, and (4) the best shape for the entrance approach to the gates. The model was constructed on a scale of 1:80. Both gravity and arch dam models were studied.—*H. E. Babbitt.*

Second Steel-Faced Dam Built for Colorado Springs. ANON. Eng. News-Rec., 117: 599 (1936). Colorado Springs, city of 38,000 people, has summer tourist population which doubles census population. Water supply is derived from slopes of Pikes Peak, power being developed from high heads available as required. South slope watershed had been completely developed and drought of 1934 accelerated development of north slope on 27.2 square miles of forest preserve area on which city had obtained flowage and storage rights from federal government years ago. Water available from this development is estimated at 6 m.g.d. average throughout year and 15 m.g.d. maximum. Together with south slope water, this will supply 100,000 population expected in 1960. When all water under rights obtained has been utilized, metering will be actively promoted. At present only 6.13% of services are metered. North slope development consists of 2 dams located 15 miles from city, 9.43 miles of 20- and 24-inch steel pipe line skirting steep cliffs and slopes leading through Cascade hydro unit, where pressure is 1,000 pounds per square inch, to Manitou hydro plant where pressure is 300 pounds at elevation more than 2,500 feet below dam outlet. In line are 9 tunnels, aggregating 13,794 feet, within which pipe are laid. To dissipate unused head, nozzle head-reducer is inserted in end of line. One of north slope dams, Crystal Creek Dam, was completed in 1935 and second, Catamount Creek Dam, is under construction. Both structures, which dam adjacent streams, consist of fill of disintegrated granite faced in major part with steel plates, remainder of faces being reinforced concrete slab extending to concrete cutoff toewall carried down into solid rock. In each case, concrete-lined spillway will carry overflow around left end of dam and outlet is concrete-lined tunnel in which are laid 2 steel pipes. Pipe line to city is novel in that there are no siphons and maximum head reaches 1,909 feet which, since it is not yet needed for power, must be dissipated before entering city distribution system. Investment cost per acre-foot of storage capacity of Crystal Creek Dam and reservoir is $121 and cost per acre-foot of annual water yield $563, for Catamount Creek Dam and reservoir $240 and $468, respectively, and for combined projects (estimated net annual yield of 2,032 acre-feet) $170 and $503, respectively.—*R. E. Thompson.*

Quabbin Earth Dam, Massachusetts. ANON. Eng. News-Rec., 117: 530 (1936). Quabbin Dam, last major structure in development of Quabbin Reservoir project on Swift and Ware Rivers, was placed under contract in July by Metropolitan District Water Supply Commission. Dam, located on Swift River near Enfield, Massachusetts, is hydraulic fill embankment containing 3,850,000 cubic yards of earth and 150,000 cubic yards of riprap facing on upstream slope. Principal dimensions are: crest length, 2,650 feet; maximum height, 165 feet; base width, about 720 feet. Impervious central core, 100 feet wide at base and 14 feet at top, will be held in place by pervious shoulders. Under previous contracts, concrete corewall to rock, diversion tunnel, and upstream and downstream cofferdams have been built.—*R. E. Thompson.*

Geology of Dam Sites in Shale and Earth. W. J. MEAD. Civ. Eng., 7: 392 (1937). The term "shale," as used in this article, includes all fine-grained sedimentary rocks, without regard to bedding laminations, which were orig-

inally deposited in the form of clay or mud and have undergone various degrees of solidification and lithification by processes of compaction, crystallization, and cementation. Shales may be divided into two types: (1) Compaction shales, and (2) Cemented shales. The former slake and disaggregate when acted upon by water after partial or complete drying, the rapidity and completeness of complete disaggregation being largely dependent upon the completeness of the drying. Cemented shales are much more reliable from the standpoint of bearing strength, and ordinarily will not tend to yield by flowage under dam construction. In the preparation of shale foundations for concrete after excavating any alluvial material from the stream bed, all deteriorated shale should be removed so as to expose fresh, unaltered natural surfaces. The exposure of compaction shale to other than a saturated atmosphere results in loss of water by evaporation with accompanying development of shrinkage cracks. In earth dams founded on rock, the problem of bearing strength in effect disappears, but the problems of leakage through rock under and around the structure are no different from those for a concrete dam. The treatment of earth dam foundations which consist of boulder deposits, gravel, sand, or mixtures of these materials, involves only the question of the control of leakage through the foundation. River-deposited sand is characteristically laid down with a high percentage of voids. This open-packed sand is susceptible to compaction under the load of a dam, but the amount of compaction which it will undergo under a given load is not proportional to its initial percentage of voids. Much attention has been given and is being given to investigations of the bearing strength of clay in the field of soil mechanics, and excellent progress as been made in developing methods of analysis of clay foundation conditions by investigation of the distribution of shearing stresses, and by measurements of shearing strength, clastic properties, and degree of compaction.—*H. E. Babbitt.*

Steep Concrete Face on Rockfill Dam in China. ANON. Eng. News-Rec., 117: 677 (1936). Earthquake hazard and desire for economy in use of cement led to adoption of novel design for rockfill dam constructed on Shing Mun River in China. Dam consists of 5 parts. Face is relatively thin diaphragm built of rich reinforced concrete divided into segments by vertical bitumen-filled joints so that it can stand considerable distortion without destruction. Cutoff wall is formed by extension of face downward to impervious rock, wall being constructed of rich unreinforced concrete carefully placed for maximum density. Back of face and cutoff wall is "thrust block" of low-grade mass concrete, resting on surface rock and designed to transmit water pressure to rockfill behind, and finally, to ensure uniform transmission of pressure thrust block and rockfill, wedge of dry sand is inserted between these elements. Dam is located about 12 miles from Kowloon, which is separated from Hong Kong by arm of sea about 1 mile wide, and forms Jubilee reservoir, which provides additional water supply to both these communities. Location is across narrow gorge and although height above streambed level is 275 feet, length at top water level is only 695 feet.—*R. E. Thompson.*

How Shall the Height of Dams Be Measured. ANON. Eng. News-Rec., 117: 816 (1936). Brief general discussion of problem of expressing dam height.

Present variation of practice appears sufficient to warrant study of subject by special committee of recognized authorities with view to preparing definition of dam height capable of universal adoption as standard practice. After satisfactory definition has been formulated, it may prove desirable to have standing committee ready to pass upon questions of proper rating of dam height whenever new conditions present a specific question. (Correction in Eng. News-Rec., 117: 939 (1936).)—*R. E. Thompson.*

Photogrammetric Surveys Give Dam and Quarry Yardage. Paul Baumann. Eng. News-Rec., 117: 915 (1936). Five photogrammetric surveys have been made recently in San Gabriel Canyon for Los Angeles County Flood Control District. In each case, check survey was made by usual ground methods, results agreeing very closely. Rapidity and comparatively low cost of surveys made with airplane equipment have made it well worth while to employ this method. Outline of different purposes served and nature and cost of surveys is given. First survey was for locating and comparing possible dam sites and other 4 related to quantities of material, which were calculated from topography as represented by contours.—*R. E. Thompson.*

Scour Prevention Below Bonneville Dam. J. C. Stevens. Eng. News-Rec., 118: 61 (1937). Some 140 model experiments were made on as many combinations of deck, apron, baffle, etc., before final profile and type of baffle for Bonneville Dam were decided upon. Adopted baffle consists of wedge-shaped blocks 6 feet wide and 6 feet high with 1:1 sloping faces both upstream and downstream. Blocks are in 2 transverse rows with 6-foot spaces between blocks in each row and 30-foot space between rows. Blocks in one row are opposite spaces in other. This particular baffle block, which is believed not to have been used heretofore, was adopted for 3 reasons: (1) least movement of bed material, (2) simplicity of construction, and (3) easy maintenance. Caisson has been designed for exposing 3 blocks at time for examination and repair. Decided advantage was found in favor of sloping back compared with vertical. —*R. E. Thompson.*